The Pharmacy Calculations Workbook

by: Dr. Murali Ramanathan

A problem-based approach to better pharmacy and dosing calculations skills.
The Pharmacy Calculations Workbook

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Buffalo, New York

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CHAPTER 1
PRESCRIPTION INTERPRETATION
## MEDICAL ABBREVIATIONS

Abbreviations for disease states and physiologic states

<table>
<thead>
<tr>
<th>Term</th>
<th>Meaning</th>
</tr>
</thead>
<tbody>
<tr>
<td>ADHD</td>
<td>Attention Deficit and Hyperactivity Disorder</td>
</tr>
<tr>
<td>BM</td>
<td>Bowel Movement</td>
</tr>
<tr>
<td>BP</td>
<td>Blood Pressure</td>
</tr>
<tr>
<td>BPM</td>
<td>Beats per Minute</td>
</tr>
<tr>
<td>CA</td>
<td>Cancer, carcinoma</td>
</tr>
<tr>
<td>CAD</td>
<td>Coronary Artery Disease</td>
</tr>
<tr>
<td>CHF</td>
<td>Congestive Heart Failure</td>
</tr>
<tr>
<td>COLD/COPD</td>
<td>Chronic Obstructive Lung/Pulmonary Disease</td>
</tr>
<tr>
<td>CVA</td>
<td>Cerebral Vascular Accident, stroke</td>
</tr>
<tr>
<td>DM</td>
<td>Diabetes Mellitus</td>
</tr>
<tr>
<td>FBS</td>
<td>Fasting Blood Sugar</td>
</tr>
<tr>
<td>GERD</td>
<td>Gastro-esophageal Reflux Disease</td>
</tr>
<tr>
<td>GI</td>
<td>Gastrointestinal</td>
</tr>
<tr>
<td>ESRD</td>
<td>End Stage Renal Disease</td>
</tr>
<tr>
<td>HA</td>
<td>Headache</td>
</tr>
<tr>
<td>HBP, HTN</td>
<td>High Blood Pressure, Hypertension</td>
</tr>
<tr>
<td>HR</td>
<td>Heart Rate</td>
</tr>
<tr>
<td>MI</td>
<td>Myocardial Infarction, heart attack</td>
</tr>
<tr>
<td>NKA/NKDA</td>
<td>No Known Allergies/No Known Drug Allergies</td>
</tr>
<tr>
<td>N&amp;V, N/V</td>
<td>Nausea and Vomiting</td>
</tr>
<tr>
<td>OA</td>
<td>Osteoarthritis</td>
</tr>
<tr>
<td>RA</td>
<td>Rheumatoid Arthritis</td>
</tr>
<tr>
<td>RR</td>
<td>Respiration Rate</td>
</tr>
<tr>
<td>SOB</td>
<td>Shortness of Breath</td>
</tr>
<tr>
<td>Temp</td>
<td>Body Temperature</td>
</tr>
<tr>
<td>URI</td>
<td>Upper Respiratory Infection</td>
</tr>
<tr>
<td>UTI</td>
<td>Urinary Tract Infection</td>
</tr>
<tr>
<td>Term</td>
<td>Meaning</td>
</tr>
<tr>
<td>--------</td>
<td>--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>amp.</td>
<td><strong>Ampule.</strong> A hermetically sealed glass vessel containing a sterile drug solution usually used parenteral administration. The ampule is broken and the solution drawn into a syringe under aseptic conditions just prior to administration. Ampules are always single dose units. <strong>Vials</strong> are glass containers with a rubber stopper through which a hypodermic needle can be inserted to remove its contents. Vials can be either single use or multiple use depending on whether a bacteriostatic preservative is present in the solution.</td>
</tr>
<tr>
<td>cap.</td>
<td><strong>Capsule.</strong> A shell usually made of gelatin that contains the active ingredients in powder or liquid form. When the capsule is swallowed, the gelatin dissolves in the acid environment of the stomach releasing the material inside.</td>
</tr>
<tr>
<td>chart.</td>
<td><strong>A divided powder, powder in a paper.</strong> The drug or drug mixture is wrapped in folded paper. The patient unfolds the paper and transfers the contents to a tablespoon or a glass and dissolves the contents in water. This solution is swallowed and washed down with water. Archaic dosage form.</td>
</tr>
<tr>
<td>cr., crm.</td>
<td><strong>Cream.</strong> A semisolid preparation containing drug intended for application to body surfaces like the skin. Creams are heterogenous systems (an oil in water mixture) whose continuous phase is either aqueous or water soluble. Creams absorb into the skin leaving little oily residue.</td>
</tr>
<tr>
<td>elix.</td>
<td><strong>Elixir.</strong> An oral solution containing drug, water, and some alcohol. When the active ingredients are dissolved exclusively in alcohol the dosage form is called a Spirit.</td>
</tr>
<tr>
<td>emul.</td>
<td><strong>Emulsion.</strong> A liquid, heterogenous dosage form in which a liquid oil is usually dispersed in a continuous aqueous phase. Usually the drug is dissolved in the internal oil phase. When an emulsion is used topically it is frequently called a lotion. (Topical lotions may also be called suspensions)</td>
</tr>
<tr>
<td>Liq.</td>
<td>A solution</td>
</tr>
<tr>
<td>Lot.</td>
<td>A lotion.</td>
</tr>
<tr>
<td>Parenteral</td>
<td>The word <strong>Parenteral</strong> is used to indicate routes of administration other than the gastrointestinal tract</td>
</tr>
<tr>
<td>pulv., pulvis</td>
<td><strong>A bulk powder.</strong> Applied directly to the skin from the container.</td>
</tr>
<tr>
<td>sol.</td>
<td><strong>Solution.</strong> A solution of drug usually in water. May be taken by mouth or applied to skin depending on indication.</td>
</tr>
<tr>
<td>supp., sup., suppos</td>
<td><strong>Suppository.</strong> Firm semisolid dosage forms that are designed to be inserted into a particular body opening. The semisolid vehicle melts at body temperature releasing the incorporated drug into the local body fluids. Rectal and vaginal suppositories are most common.</td>
</tr>
<tr>
<td>susp.</td>
<td><strong>Suspension.</strong> A liquid, heterogenous dosage form in which a solid is dispersed in the liquid. Usually the drug is not dissolved in the dosage form. When the suspension is used topically it is frequently called a lotion.</td>
</tr>
<tr>
<td>syr.</td>
<td><strong>Syrup.</strong> A solution that is sweet and highly viscous. Rarely, used for syringe.</td>
</tr>
</tbody>
</table>
THE ANATOMY OF A PRESCRIPTION

CHECKING THE DEA NUMBER

- All physician DEA numbers begin with TWO LETTERS.
- The FIRST LETTER is A, B, or F with doctors (MD, DO, etc.), M for midlevels (NP, PA, etc.)
- The SECOND LETTER is the first letter of the physicians LAST NAME or MAIDEN NAME.
- Add digits 1, 3, 5
- Add digits 2, 4, 6 and multiply by 2.
- Add the two totals.
- The LAST digit of the sum is the same as the last digit of the DEA number

Example

Take DEA # AH0354213 from Dr. Alfred K. Hall

Is the 1st letter A, B, or F? Yes, it's A
Is the 2nd letter the same as 1st letter of the physician's last name? Yes, it's H
The following are prescriptions from very busy physicians that you receive. You are to interpret these prescriptions in simple layman terms so a patient would understand. Please mark your interpretations below each prescription.

**Problem 22**

**R**

ASA  
APAP  aa 9 g  
M.ft. div. #30 caps  
Sig: 1 cap PO Q 4 H PRN HA

Refill: 0 x

H Alfayad, M.D.

THIS PRESCRIPTION WILL BE FILLED GENERICALLY UNLESS THE PRESCRIBER WRITES "d a w" IN THE BOX BELOW

Dispense as written
### Problem 23

<table>
<thead>
<tr>
<th>Phone 333-232-1234</th>
<th>Phone 333-232-1234</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dr. Paige Turner, MD, PC</td>
<td>Dr. Paige Turner, MD, PC</td>
</tr>
<tr>
<td>126 Potboiler Street</td>
<td>126 Potboiler Street</td>
</tr>
<tr>
<td>Buffalo, NY 14260</td>
<td>Buffalo, NY 14260</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Name</th>
<th>Jay Walker</th>
<th>Age</th>
<th>36</th>
</tr>
</thead>
<tbody>
<tr>
<td>Address</td>
<td>237 Crosswalk St, Buffalo, NY</td>
<td>Date</td>
<td>9/5/03</td>
</tr>
</tbody>
</table>

**Rx**  
Tobramycin 0.3% sol.  
Disp: 10 mL  
Sig: 4 gts. AD Q 8 H ATC TG  
Refills: 0

**P Turner, M.D.**

*THIS PRESCRIPTION WILL BE FILLED GENERICALLY UNLESS THE PRESCRIBER WRITES "d a w" IN THE BOX BELOW*

**DAW**

Dispense as written
### Problem 24

<table>
<thead>
<tr>
<th>Name</th>
<th>Curt Connors</th>
<th>Age</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Address</td>
<td>237 Lizard Lane, Brooklyn, IL</td>
<td>36</td>
<td>9/5/03</td>
</tr>
</tbody>
</table>

Nystatin 100,000 U/mL susp.  
Viscous Lidocaine 2%  
Diphenhydramine liq.  
M.ft. 180 mL susp., disp. 90 mL  
Sig: Swish and spit 1 tsp. Q1D x3d, T1D x4d  
Refills: 0

Dr. Wilson Fisk, MD, PC  
126 Kingpin Court  
Brooklyn, NY 14260

DEA BF-9345679

Phone 333-232-1234

THIS PRESCRIPTION WILL BE FILLED GENERICALLY UNLESS THE PRESCRIBER WRITES "d a w" IN THE BOX BELOW

Dispense as written
Problem 25

<table>
<thead>
<tr>
<th>Name</th>
<th>Gwen Stacy</th>
<th>Age</th>
<th>36</th>
</tr>
</thead>
<tbody>
<tr>
<td>Address</td>
<td>237 Greengoblin Lane, Queens, NY</td>
<td>Date</td>
<td>9/9/06</td>
</tr>
</tbody>
</table>

Rx

Trimethobenzamide  200mg
Polybase  qs
M.ft. SA dtd #10 supp.
Sig: 1 supp. pro. rect. TID PC PRN N/V

Refills: 2

Dr M.J. Watson, M.D.

This prescription will be filled generically unless the prescriber writes "d a w" in the box below.
### Problem 26

<table>
<thead>
<tr>
<th>Name</th>
<th>Joe Robertson</th>
</tr>
</thead>
<tbody>
<tr>
<td>Address</td>
<td>87 Stanlee St, Queens, NY</td>
</tr>
<tr>
<td>Age</td>
<td>21 yr</td>
</tr>
<tr>
<td>Date</td>
<td>8/18/97</td>
</tr>
<tr>
<td>Height</td>
<td>5’6”</td>
</tr>
<tr>
<td>Weight</td>
<td>180 lb</td>
</tr>
</tbody>
</table>

**Atrovent inhalation solution**

Disp: #60 amp.

Sig: inhale contents of 1 amp. PO via nebulizer ut dict Q 4 H or PRN SOB

Refills: 0; DAW

H Kraven, MD
### Problem 87

<table>
<thead>
<tr>
<th>Name</th>
<th>Alegria Mirth</th>
<th>Age</th>
<th>21</th>
</tr>
</thead>
<tbody>
<tr>
<td>Address</td>
<td>27 Main St, Buffalo, NY 14123</td>
<td>Date</td>
<td>9/21/2000</td>
</tr>
</tbody>
</table>

Rx  
Auralgan EarSuspension IOP

Sig: 2-3 drops au tid prn ear ache

Ella Risa M.D.

THIS PRESCRIPTION WILL BE FILLED GENERICALLY UNLESS THE PRESCRIBER WRITES "D A W" IN THE BOX BELOW

Dispense as written
CHAPTER 2

SIGNIFICANT FIGURES
Rules for determining significant figures

Arithmetic with Significant figures

Measurement errors

Rules For Significant Figures

A significant figure conveys an estimate of measurement accuracy to the reader. It lets you say what you mean and mean what you say about numbers.

In the significant figures convention, measurements are always expressed with enough digits so that only the last digit has any uncertainty.

You must discriminate between decimal places and significant figures. For example, the number 12.34 has four significant figures but only two decimal places.

Remember, your calculator knows more about decimal places and YOU know more about significant figures.

For example, consider the value 12; if it is expressed as $1.2 \times 10^1$ or 12, the author implies that the actual value is greater than 11.5 and less than 12.5. It has two significant figures. If the same number is written as $1.20 \times 10^1$ or 12.0, the author implies that the actual value is greater than 11.95 and less than 12.05. This representation has three significant figures.

Zeroes to the left of the first non zero digit are not significant. Thus, 0.00123 and 0.123 both have three significant figures.

Zeroes to the right of the decimal point are significant if the decimal point is preceded by a non zero integer.

Zeroes to the right of the last non zero digit in a whole number can be ambiguous. For example, it is hard to tell whether 123000 has three significant figures or six. To clear up problems like this, use exponential notation – Write $1.23 \times 10^5$ if you want the number to have three significant figures; $1.230 \times 10^5$ for four and so on.

Arithmetic with Significant Figures

When adding or subtracting, round off the result to the number with least number of DECIMAL places.

When multiplying or dividing, round off the result to the number with least number of SIGNIFICANT figures.
**Problem 4**

Use the **mathematical rules** for determining the significant figures in your answer for this question.

a. 

b. 

c. 

For each of these devices read the volume at the line with the arrows (DO NOT read at the barrel of the syringe).
Problem 7

Use the MATHEMATICAL RULES for significant figures for all 3 parts of this problem.

a. The stadiometer is a device used to measure height of patients in caregivers’ offices. The following images summarize a measurement situation. Please read the height of the patient to the correct number of significant figures.

![Stadiometer Image]

**Height =**

b. The same patient is weighed on a scale. The table shows the readout on the scale. Read the weight of the patient to the correct number of significant figures.

![Scale Image]

**Weight =**

c. The caregiver’s office computes the body mass index (BMI), a measure of obesity from the height and weight measurements. The BMI is computed using the formula below and the numerical value obtained from a calculator is also indicated.

\[
BMI = \frac{\text{Weight in kg}}{(\text{Height in meters})^2} = 37.674269 \text{ kg} / \text{m}^2
\]

Round off the BMI value to the appropriate number of significant figures and write your answer in the space below. Be sure to indicate the correct units.

**BMI =**
CHAPTER 3
UNITS AND CONVERSIONS
NOTES

Metric System

• The metric system is the official system for weights and measures. This workbook assumes that you are familiar with the metric system.

• You should also be familiar with suffixes such as pico \((10^{-12})\), nano \((10^{-9})\), micro \((10^{-6})\), milli \((10^{-3})\), centi \((10^{-2})\), deci \((10^{-1})\), deka \((10)\), kilo \((10^3)\), mega \((10^6)\), giga \((10^9)\) and tera \((10^{12})\)

Apothecary and Avoirdupois Systems

In the United States, the Apothecary and Avoirdupois systems are occasionally used in the pharmacy and in commercial practice.

WEIGHT UNITS IN THE APOTHECARY SYSTEM

<table>
<thead>
<tr>
<th>UNIT A</th>
<th>UNIT B</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 scruple (ɜ)</td>
<td>20 grains (gr)</td>
</tr>
<tr>
<td>1 dram or drachm (ʒ)</td>
<td>3 scruples = 60 grains</td>
</tr>
<tr>
<td>1 apothecary ounce (ʒ)</td>
<td>8 drams = 24 scruples = 480 grains</td>
</tr>
<tr>
<td>1 apothecary pound (f̄b)</td>
<td>12 apothecary ounces = 96 drams = 5760 grains</td>
</tr>
</tbody>
</table>

WEIGHT UNITS IN THE AVOIRDUPOIS SYSTEM

<table>
<thead>
<tr>
<th>UNIT A</th>
<th>UNIT B</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 avoirdupois ounce (oz)</td>
<td>437 ½ grains</td>
</tr>
<tr>
<td>1 avoirdupois pound (lb)</td>
<td>16 ounces (oz) = 7000 grains</td>
</tr>
</tbody>
</table>

• Note that the apothecary grain and the avoirdupois grain are equal. However, the apothecary ounce and apothecary pound are not equal to the avoirdupois ounce and the avoirdupois pound, respectively. Confusing enough?

• The apothecary pound is sometimes denoted with lb symbol with a slash through it: f̄b.

• The pound used in the United States to obtain patient’s body weight and on commercial items in the grocery store is the avoirdupois pound.
Problem 2

There is really no alternative to memorization for remembering conversion factors. The following problems will test your ability to remember these conversion factors. Fill in the blanks with the correct answer and circle one choice in the parenthesis.

a. 1 fl oz = ____________________________ ml (exact approximate)

b. 1 lb. avoir = ____________________________ kg (exact approximate)

c. 10 oz avoir = ____________________________ gr (exact approximate)

d. 1 apoth. = ____________________________ gr (exact approximate)

e. 1 lb apoth = ____________________________ kg (exact approximate)

f. 100 ml = ____________________________ minim (exact approximate)

g. 1 g = ____________________________ gr (exact approximate)

h. 1/4 fl oz = ____________________________ minim (exact approximate)

i. 1 gallon = ____________________________ fl oz (exact approximate)

j. 2 gr = ____________________________ mg (exact approximate)
Problem 22

Name: Gary Snail
Address: 87 Patrick Lane, Bikini Bottom
Age: 26 yr
Date: 8/18/97
Height: 5’8”
Weight: 128 lb

R. Sponge, MD

---

a. What is the total weight (in grains) of aspirin required to compound this prescription?

---

b. The minimum weighable quantity for a prescription balance is 120 mg. Is this amount greater than, less than or equal to the minimum weighable quantity for a legal prescription balance?

---

c. How many grains of lactose are needed to compound this script?

---

d. Which apothecary weights should be used to weigh the total powder mass? Your apothecary weight set has the following weights:

\[ \text{gr ii}, \text{ gr iii}, \text{ gr ss}, \text{ gr i}, \text{ gr ii}, \text{ gr i}, \text{ gr ss}, \text{ gr v}, \text{ gr iv}, \text{ gr iii} \]

---
Problem 24

Phone 714-321-1234

Dr. Maisy Gibbons, M.D.
3 Transit Road
Amherst, NY

DEA# AB0365420

Pet Owner
Address
Rex
Libby Collins
87 Transit Rd, Amherst, NY

Animal
Age
Date
Dog
18 mo
8/18/97

Weight
20 lb

R
Diazepam
gr. 1/3.
Lactose qs ad
gr. ii
DTD. 10 caps
Sig. 1 cap qd with food for epilepsy

M. Gibbons, MD

a. What is the total weight (in grains) of diazepam required to compound this prescription?

b. What is the total weight (in mg) of diazepam required to compound this prescription?

c. What is the total weight (in grains) of lactose required to compound this prescription?

d. Circle the apothecary weights that will be used to weigh out the total amount of titurated powder mass: A typical weight box consists of the following units.

\[
\begin{align*}
\text{gr iii} & , \text{ gr ii} , \text{ gr i} , \text{ and gr ss} \\
\text{gr v} & , \text{ gr iv} \\
\text{gr ss} & , \text{ gr ii} , \text{ gr i} , \text{ and gr ss}
\end{align*}
\]
Problem 31

Cameron Caiman
El Gato, TX 90210

Name Marmota Loro Age 23 Wt 200 lb
Address Perro Street, El Gato Date 1/10/95 Height 5 ft 10 in

Refill Aspirin
Div caps #200. Sig: i c tid

Cameron Caiman M.D.

A typical weight box consists of the following units.
\[ \text{3ii, 3i, 3ss, 3ii, 3i, 3ss, 3ii, 3i, 3ss, gr v, gr iv,} \]
\[ \text{gr iii, gr ii, gr i, and gr ss} \]

a. Pick out the weights required to weigh the total amount of aspirin for all capsules.

b. Express the single dose of aspirin in milligrams.

c. Express the patient’s weight in kilograms.

d. Express the patient’s height in centimeters.

e. The body mass index is used to assess whether a patient is obese or underweight. Use the formula below to calculate the patient’s body mass index.

\[ \text{Body mass index} = \frac{\text{Weight in kg}}{(\text{Height in meters})^2} \]
Problem 32

<table>
<thead>
<tr>
<th>Name</th>
<th>Mariquita Polilla</th>
<th>Age</th>
<th>23</th>
<th>Wt</th>
<th>200 lb</th>
</tr>
</thead>
<tbody>
<tr>
<td>Address</td>
<td>Mosca Street</td>
<td>Date</td>
<td>1/1/95</td>
<td></td>
<td>Height</td>
</tr>
<tr>
<td>Refill</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>A Alacran, M.D.</td>
</tr>
<tr>
<td>Drug</td>
<td>NTG</td>
<td></td>
<td></td>
<td></td>
<td>1/200 grains</td>
</tr>
<tr>
<td>DTD caps</td>
<td>#100</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sig:</td>
<td>2 c sl prn angina</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

a. What is the drug?

b. What is the route of administration?

c. What is the dose of drug in grains?

d. What is the dose of drug in micrograms?
**Problem 37**

Phenytoin sodium, a drug used to control epileptic seizures, was originally prescribed as gr. ss and gr. iss capsules. Phenytoin sodium is now commercially available as 30 and 100 mg capsules and yet some physicians, out of tradition, still prescribe it in grains. "According to the art", prescriptions for Phenytoin sodium gr. iss are now dispensed as 100 mg capsules. Prescriptions for Phenytoin sodium gr. ss are now dispensed as the smaller pediatric 30 mg capsules.

a. Dr. Saura has been effectively controlling a patient’s epilepsy with a prescription for Phenytoin sodium gr iss TID for over a year. You have been correctly filling this prescription with 100 mg capsules. The doctor now reports to you that his patient is having difficulty swallowing the larger gr iss capsules and wants you to refill the prescription using three gr. ss capsules TID (after all, he believes that "3X gr ss" = "gr iss"). If you dispense three, 30 mg capsules per dose what is the difference, in mg/dose, between the original 100 mg capsules and this new prescription?

b. How many grains are there in a milligram?

c. What is the difference, in grains/dose, between three, 30 mg pediatric capsules and the original 100 mg capsule

d. You decide to call Dr. Saura back and recommend phenytoin oral suspension, (phenytoin sodium 33 1/3 mg/5ml) instead of the smaller capsules. What volume of this suspension, in ml, would be equivalent to the 100 mg capsules?
Problem 38

Dr. Jasmine Alladin, M.D.
22 W. Sultan Blvd
Agrabah, OR

Name: Ariel Flounder
Address: 1 Triton Ave, Sebastian, OR
Age: 15 yr
Height: 5 ft 8 in
Date: 8/18/97
Weight: 90 kg

R
Phenacetin gr. xxiv
ASA gr. xxxvi
Caffeine gr. vi
Codeine sulfate gr. vi
Mft div caps 12
Sig: 1 cap q4h prn pain. Max dose 6 caps daily
Jazzie Alladin, MD

a. Calculate the weight in grains of the total contents of each capsule.

b. It is important to limit the maximum daily dose of this medication because phenacetin can cause kidney damage. What is the maximum daily dose of phenacetin in mg.

c. Without converting units, determine how many pounds (avoirdupois) of phenacetin are required to prepare 18 pounds (avoirdupois) of the formula?

d. How many scruples of phenacetin are required to prepare 144 scruples of the formula?

e. How many grams of phenacetin are required for preparing 3.6 kg of product?
NOTES

Outline

• Definitions
• Determinants of dosing
• Why bother about dosing?
• Parenteral routes of administration?
• Household measures
• Approximate & Exact equivalents
• Calculating drug dosage
• Dosing for children
• Body surface area method

Some Formalism

• DOSE refers to the AMOUNT of drug administered, expressed as a mass.
  • Single dose
  • Total dose
  • Daily dose
• Usual adult dose is the amount that may be expected produce the intended effect in adults.
• Usual pediatric dose is similarly defined for children.
• Usual dosage range represents the amounts that may be prescribed within the guidelines of medical practice.
• Distinguish between DOSE and DOSAGE FORM. A given dose may be administered in a variety of dosage forms. For example a dose of 100 mg can be given as solution, as a tablet, as capsules etc.
• For clarity, we will use the word “amount” to refer to the drug and the word “quantity” to refer to the preparation.

Determinants Of Dosing

• As a health care professional, dosing is among most critical and frequent decisions you will be involved with.
• There are numerous factors that are important in determining the drug choice and dose of a given drug. These factors are summarized in the Figure 4.1 below (Adapted from M. Rowland and T.N. Tozer, Clinical Pharmacokinetics: Concepts and Applications). Pharmaceutical calculations, the subject matter of this Workbook are important because they
enable integration of the many pathophysiological, pharmacological, physicochemical and other factors to be considered.

Figure 4.1. Determinants of a dosing regimen.

Why Bother About Dosing?

• The dose is the primary determinant of the concentration of drug in blood. The concentration in blood determines the drug concentration at the site of action. The drug concentration at the site of action determines the magnitude of effect.

• Dose → Blood Concentration → Concentration at Site of Action → Effect

• Minimum Effective Concentration (MEC) → Blood serum concentration that produces desired effect.

• Minimum Toxic Concentration (MTC) → Blood serum concentration that produces toxic effects.

• You want to maintain concentrations between MEC and MTC for the desired period of time.

• As drug concentration in plasma increases, the likelihood of effectiveness increases and the likelihood of ineffectiveness decreases. However, larger increases in drug concentration results in an increase in minor and then major toxicities. There is also a risk of hypersensitivity reactions, which can occur even at very low concentrations and are shown as relatively concentration independent. Figure 4.2 is a schematic that illustrates the dependence of drug effects on concentration. The green curve represents the difference between effectiveness and toxicity. Notice there is an optimum drug concentration that is preferred so that net effectiveness can be maximized. The schematic is adapted from a Figure for the cardiac drug procainamide (J. Koch-Weser, Pharmacology and the Future: Problems in Therapy, G.T. Okita and G.H. Archeson eds. Karger, Basel, 1973, 3, 69-85).
Figure 4.2. Figure 4.2A is schematic of the dependence of drug effects and side effects on plasma concentration. Figure 4.2B is a qualitative assessment of drug therapy to society. On both graphs, the effectiveness curve is in blue, the ineffectiveness curve is in gray, the minor and major toxicities are in orange and red, respectively, and the hypersensitivity curve is in yellow. In Figure 4.2A, the difference between effectiveness and toxicity is in green whereas in Figure 4.2B, the net value curve is in green. The drug concentrations on the x-axis are in arbitrary units on both Figures. The drug concentration region with positive value to society is filled in green.

- Figure 4.2B shows that for drug therapy to be useful to society at large, drug concentrations have to be maintained within the window of concentrations filled in green. The calculations are in arbitrary units with positive values being beneficial to society. The value calculations were based on Figure 4.2A and a weighted sum was obtained after assigning a value of +1 to effective treatment, –1 to minor toxicities and –5 to both hypersensitivity reaction and major toxicities. Note that both low and high concentrations are potentially harmful to society at large.

Parenteral Routes Of Administration

- Routes of administration can be classified as Topical, Enteral or Parenteral.

- Parenteral routes involve drug administration at sites other than the gastrointestinal tract whereas the enteral routes involve the gastrointestinal tract. Topical routes involve direct application of drug at a surface where effect is desired.

- Examples of topical routes include:
  - Epicutaneous: On the surface of the skin. Sunscreen, ointments, creams, lotions containing various drugs are often applied directly where needed on the skin.
  - Vaginal: Into the vagina. Antifungal agents used to treat yeast infections, estrogens and progesterone and douches are examples.
  - Eye or Ear: Application on the outside of the eye or ear. Examples are antibiotic-containing eye drops for treating conditions such as conjunctivitis.

- Oral and rectal dosing are enteral routes. Feeding tubes and gastrostomy tubes, which provide direct stomach access, are also enteral routes.
Problem 6

Dr. Sienna Odyssey, M.D.
3 Caravan Ave
Sedona, AZ

<table>
<thead>
<tr>
<th>Name</th>
<th>Address</th>
<th>Age</th>
<th>Height</th>
</tr>
</thead>
<tbody>
<tr>
<td>Previa Windstar</td>
<td>87 Lumina Lane, Sedona</td>
<td>45 yr</td>
<td>5 ft 8 in</td>
</tr>
</tbody>
</table>

Date: 8/18/97
Weight: 90 kg

Aluminium hydroxide suspension 600 mg/5 ml
Sig: 30 ml qid for hyperphosphatemia for 2 weeks

S Odyssey, MD

---

a. What instructions would you give the patient?

---

b. How much drug is in a single dose?

---

c. What is the route of administration?

---

d. What is the dosage form?

---

e. Determine the **daily** dose in mg/kg.

---
Problem 7

Dr. Ira Roth, M.D.
401K Exempt Ave
Taxhaven, CA

<table>
<thead>
<tr>
<th>Name</th>
<th>Address</th>
<th>Age</th>
<th>Date</th>
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<th>Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Penny Bond</td>
<td>87 Hedge Lane, Stockton, CA</td>
<td>45 yr</td>
<td>8/18/92</td>
<td>5 ft 8 in</td>
<td>90 kg</td>
</tr>
</tbody>
</table>

R
Phenytoin sodium gr iss
Phenobarbital gr ¼
Dtd caps #100
Sig: 1 cap qid

Ira Roth, MD

DILANTIN DOSAGE FORMS

N 0071-0362 (Kapseal362, transparent #3 capsule with an orange band) – Dilantin 100 mg; in 100's, 1,000's, and unit dose 100's and in a Memo Pack containing 84 unit dose capsules (28 days dosage regimen).

N 0071-0365 (Kapseal 365, transparent #4 capsule with a pink band) – Dilantin 30 mg; in 100's, 1,000's and unit dose 100's.

N 0071-2214 – Dilantin-125® Suspension 125 mg phenytoin/5 ml with a maximum alcohol content not greater than 0.6 -percent, available in 8-oz bottles and individual unit dose foil pouches which deliver 5 ml (125 mg phenytoin). The minimum sales unit is 100 pouches.

N 0071-2315 – Dilantin-30® Pediatric Suspension 30, mg phenytoin/5 ml with a maximum alcohol content not greater than 0.6 percent; available in 8-oz bottles and individual unit dose foil pouches which deliver 5 ml (30 mg phenytoin). The minimum sales unit is 100 pouches.

N 0071-0375 (Kapseal 375) – Dilantin with Phenobarbital each contain 100 mg phenytoin sodium with 16 mg (1/4 gr) phenobarbital; in 100's and 1,000's.

N 0071-0531 (Kapseal 531) – Dilantin With Phenobarbital each contain 100 mg phenytoin sodium with 32 mg (1/2 gr) phenobarbital; in 1000's, 1,000's and unit dose 100's.

N 0071-0007 (Tablet 7) – Dilantin Infatabs® each contain 50 mg phenytoin, 100's and unit dose 100's.

For Parenteral Use:

N 0071-4488-05 (Ampoule 1488) – Dilantin ready-mixed solution containing 50 mg/ml phenytoin sodium in 2-ml ampoules. Packages of ten.

N 0071-4488-41 (Steri-Dose® 4488) – Dilantin ready-mixed solution containing 50 mg/ml phenytoin sodium in a 2-ml sterile disposable syringe (22 gauge x 1 1/4 inch needle). Packages of ten individually cartoned syringes.

N 0071-4475-35 (Ampoule 1475) – Dilantin ready-mixed solution containing 50 mg/ml phenytoin sodium in 5-ml ampoules with one 6-ml sterile disposable syringe (22 gauge x 1 1/4 inch needle). Packages of ten.

N 0071-4475-08 (Ampoule. 1475) – Dilantin ready-mixed solution containing 50 mg/ml phenytoin sodium in packages of ten 5-ml ampoules without syringes.

N 0071-4488-45 Dilantin ready-mixed solution containing 50 mg/ml phenytoin sodium in 2-mL SteriVials®. Packages of twenty-five.

N 0071-4475-45 Dilantin ready-mixed solution containing 50 mg phenytoin sodium per milliliter 5-mL SteriVials®. Packages of twenty-five.
Problem (continued)

a. DILANTIN® is commercially available phenytoin sodium. Some of the dosage forms available from Parke-Davis at the time prescription was written are listed in the table ‘DILANTIN DOSAGE FORMS’ (adapted from Physicians’ Desk Reference, 46th Edition, 1992). Select the dosage form that would be best suited for this prescription. Indicate the supplier’s reference number, e.g., "N 0071-####..." in the space provided, i.e., complete the sentence: In my opinion, the appropriate commercially available product is N 0071-

b. What instructions would you give the patient?

c. How long will the medication last?

d. In the remaining questions, assume that a commercial product has been dispensed. How much phenytoin sodium does the patient receive per day?

e. How much phenobarbital does the patient receive per day?
## Problem 14

### Prescription A

**Dr. Palmera La Mancha, M.D.**  
22 Kinder Blvd  
San Clemente, NY

<table>
<thead>
<tr>
<th>Name</th>
<th>Pashmina Rove</th>
<th>Age</th>
<th>Date</th>
<th>Height</th>
<th>Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Address</td>
<td>7 Guernsey Ln, Goat Island, NY</td>
<td>45 yr</td>
<td>8/18/97</td>
<td>5 ft 8 in</td>
<td>90 kg</td>
</tr>
</tbody>
</table>

Rx  
**Atropine sulfate** 0.0004g  
**Phenobarbital** 0.015 g  
**Lactose q.s. a.d.** 0.4 g  
**Dtd caps#12**  
**Sig:** 1 q6h

Palmera LaMancha, MD

### Prescription B

**Dr. Catalana Cornish, M.D.**  
22 Delaware Ave  
Sussex, NY

<table>
<thead>
<tr>
<th>Name</th>
<th>Holland Leghorn</th>
<th>Age</th>
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<th>Height</th>
<th>Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Address</td>
<td>87 Wyandotte Lane, Sussex, NY</td>
<td>25 yr</td>
<td>8/18/97</td>
<td>5 ft 3 in</td>
<td>45 kg</td>
</tr>
</tbody>
</table>

Rx  
**Atropine sulfate** 0.0064g  
**Phenobarbital** 0.24 g  
**Lactose q.s. sa**  
**Div caps#16**  
**Sig:** 1 tid

Catalana Cornish, MD

a. You have compounded the Prescription A and have excess capsules prepared. Soon afterward, you are asked to attend to Prescription A. Could you dispense the previously compounded capsules from Prescription A for the patient Prescription B, all other considerations allowing? Justify your answer with calculations.

---

Page 4.29
Problem 21

Dr. Allen Key, M.D.
3 Starhead Ave
Screwdriver, NC

<table>
<thead>
<tr>
<th>Name</th>
<th>Philip Hex</th>
<th>Age</th>
<th>Height</th>
</tr>
</thead>
<tbody>
<tr>
<td>Address</td>
<td>87 Flat St, Screwdriver, NC</td>
<td>25 yr</td>
<td>5’9”</td>
</tr>
<tr>
<td>Date</td>
<td>8/18/97</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Weight</td>
<td>50 kg</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Crush forty 2mg chlorambucil tablets and resuspend in syrup containing 1% methylcellulose to a final volume of 40 ml. Sig: 0.2 mg/kg/day qd
Allen Key, MD

a. What is the daily dose of chlorambucil?

b. What is the concentration of the drug in the suspension in mg of drug per ml of final suspension?

c. What is the route of administration?

d. What instructions would you give the patient?

e. What is the patient’s body surface area?

f. Express the dose of chlorambucil in mg/m².
Problem 27

Dr. Clair Voyant
66 Omen Street
Salem, MA 14002

Phone 101-202-2020
DEA# BV -12736280

Name
Crystal Ball

Address
15 Prescient Ave, Salem

Age

Date
8/18/97

Height
160 cm

Weight
110 lbs

Phenylephrine hydrochloride
0.12 g/100 ml

m ft isotonic solution

ii gtt ou q4h prn

Clair Voyant M.D.

THIS PRESCRIPTION WILL BE FILLED GENERICALLY UNLESS THE
PRESCRIBER WRITES "d a w" IN THE BOX BELOW

Dispense as written

a. What instructions would you give the patient?
   ________________________________

b. What is the drug dosage form?
   ________________________________

c. What is the route of administration?
   ________________________________

d. What is the mass of a standard drop? What is the volume of a standard drop of water in cm\(^3\)?
   Assume that the volume of 1 g of water is 1 cm\(^3\).
   ________________________________

e. How much is a single dose? Assume that the preparation has properties similar to water.
   ________________________________
Problem 34

Phone 246-135-7890

Dr. Jasmine Alladin, M.D.
22 W. Sultan Blvd
Agrabah, OR

DEA# AR-12736280

<table>
<thead>
<tr>
<th>Name</th>
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<th>Weight</th>
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</thead>
<tbody>
<tr>
<td>Ariel Flounder</td>
<td>1 Triton Ave, Sebastian, OR</td>
<td>22 yr</td>
<td>8/18/97</td>
<td>160 cm</td>
<td>50 kg</td>
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</tbody>
</table>

NORDETTE-28®
Disp 4 packs
Sig: 1 cap as directed

Jazzie Alladin, MD

Each pack of Nordette-28® contains: 21 active orange tablets each containing 0.15 mg levonorgestrel and 0.03 mg ethinyl estradiol and 7 pink placebo tablets. (A placebo is a preparation with no active ingredients).

The patient is instructed to take one active tablet/day for 21 days followed by 1 placebo tablet/day for the next 7 days.

a. The dosing regimen for the pill is based on the menstrual cycle, which is 28 days long. Calculate the number of menstrual cycles in a year.

b. How many packs of Nordette-28® are required for one year?

c. Calculate the total dose of levonorgestrel administered over one menstrual cycle?

d. What is the annual dose of levonorgestrel?
e. What is the annual dose of ethinyl estradiol?


f. What is the weight normalized daily dose of ethinyl estradiol in $\mu g/kg$? Carry out the calculations for a day in which the active pill is administered.


g. Using the nomogram, determine the body surface area normalized daily dose of ethinyl estradiol in $\mu g/m^2$. Carry out the calculations for a day in which the active pill is administered.
Problem 36

Dr. Donna Prima, M.D.
3 Tenor Ave
Aintover, NC

<table>
<thead>
<tr>
<th>Name</th>
<th>Alto Baritone</th>
<th>Age</th>
<th>25 yo</th>
<th>Weight</th>
<th>71 kg</th>
</tr>
</thead>
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<tr>
<td>Address</td>
<td>Bass Ave, Aintover, NY</td>
<td>Date</td>
<td>12/23/05</td>
<td>Height</td>
<td>130 cm</td>
</tr>
<tr>
<td>Rx</td>
<td>Trimethoprim 800 mg</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Sulfamethoxazole 4 grams</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>div m ft sa x caps</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Sig: i cap bid pc</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

This is a combination antibiotic. It contains a fixed ratio of two drugs and its dosage is usually expressed in terms of trimethoprim.

a. How much trimethoprim is present in a single dose?

b. What is the route of administration?

c. What is patient’s body surface area?

d. Oral trimethoprim doses should not exceed 150 mg/m² day. Is this regimen safe? Show work.

e. Because of the severity of the patient’s pneumonia, the physician wishes to treat the patient with the highest allowable trimethoprim dose of 150 mg/m² day. How much sulfamethoxazole accompanies a single dose of trimethoprim at this level.
Problem 42

Dr. Blondie d’Aquitaine, M.D.
3 South Devon Ave
Hereford, WI

Phone 246-135-7890
DEA# BO-12736280

**Chemotherapy Regimen BACON**

- **Bleomycin**: 30 units IV day 1, weekly x6
- **Adriamycin**: 40 mg/m² IV day 1 q4w
- **CCNU (lomustine)**: 65 mg/m² po day 1 q8w
- **Vincristine**: 1 mg iv day 1 q weekly x6
- **Mechloretamine**: 8 mg/m² IV day 1 q4w

B d’Aquitaine, MD

The patient is being treated for non-small cell lung cancer caused by smoking several packs a day of nonfiltered cigarettes. Her oncologist is using the chemotherapy regimen "BACON".

a. Calculate the single dose of adriamycin. What is the route of adriamycin administration?

b. Adriamycin causes serious irreversible myocardial toxicity and congestive heart failure when the cumulative dosage exceeds 550 mg/m². After how many doses should adriamycin treatment be discontinued?

c. Calculate the single dose of CCNU required. What is the route of CCNU administration?
Problem 43

Phone 716-645-2828

Patty Sirloin
Flank Cancer Center
Brisket, NY 14002

DEA# BS -12736280

Name
Chuck Bacon

Address
Shank Street, Brisket, NY

Age
30

Date
9/23/97

Weight
80 kg

Height
5’ 11”

R
Anti-CD20 antibody 750 mg
Inject by slow IV infusion in NS qw for 6 weeks

The following table summarizes the manufacturer’s recommendations on the use of this anti-cancer agent.

<table>
<thead>
<tr>
<th>Daily dose</th>
<th>Route</th>
<th>Cycle length</th>
<th>Total Dose Cycle</th>
</tr>
</thead>
<tbody>
<tr>
<td>125 - 375 mg/m²</td>
<td>IV</td>
<td>weekly 4</td>
<td>500 – 1400 mg/m²</td>
</tr>
</tbody>
</table>

a. Determine the patient’s body surface area?

b. What is the **maximum** allowable **daily** dose for this patient? Is the prescribed daily dose safe?

c. What is the total dose received by the patient in this cycle?

d. What is the **maximum** allowable total dose per cycle? Is the prescribed total dose in the cycle safe?
CHAPTER 5
CONCENTRATION
NOTES

Outline
• Rationale
• Definitions of percent w/w, percent w/v, percent v/v.
• Ratio strength
• Interconverting from percentage to ratio strength
• Calculating amounts of ingredients required
• Calculating dosage for prescriptions with percent and ratio strength
• Problems

Definition
• In general terms, concentration is defined as follows:

\[
\text{Concentration} = \frac{\text{Amount of Drug or Ingredient}}{\text{Quantity of Preparation}}
\]

• Note that the denominator refers to the preparation, not the solvent or diluent.
• In this Workbook, “amount” will be used for the drug or ingredient and the “quantity” will be used for the preparation.
• In the United States Pharmacopoeia, the formulae for drug preparations are written for 1000 g for solid and semi-solid preparations and 1000 ml for liquid preparation. The units for solid and semi-solid ingredients are in grams and those for liquid ingredients are in ml.

Percentage Strength
• In everyday usage, percentage refers to concentration in parts per 100 parts. So a "true percentage" solution would represent, for example, the grams of solute in 100 grams of solution. Such an expression of concentration is nondimensional.
• In pharmacy however, several different conventions are used.
• Percent volume in volume (% v/v). The number of ml of ingredient in 100 ml of solution or liquid preparation.
• Percent weight in weight (% w/w). The number of grams of ingredient in 100 g of solution or mixture.
• Percent weight in weight (% w/w) and percent volume in volume (% v/v) are nondimensional.
• Percent weight in volume (% w/v). The number of grams of ingredient in 100 ml of solution or liquid preparation. This is equivalent to the number of grams of product that would be present in 100 grams of the standard, water.
Problem 2
a. What is the proof strength of “absolute” or pure ethanol?

b. What does the abbreviation U-40 mean in a prescription for insulin?

c. A chemical modified penicillin has twice the activity of the standard. Express the potency of the drug in \( \mu g \) per mg.

d. What is the density of water in units of grains/fluidounce? Show how the value is derived from a specific gravity of 1.000. Give your answer to \textbf{FOUR significant figures}. 

**Problem 3**
State which unit of percentage or ratio strength unit would most likely be used in the following situations.

a. The concentration of bismuth subsalicylate in Pepto-Bismol®.

b. The concentration of psyllium in Metamucil® powder.

c. The concentration of dextrose in D5W.

d. The concentration of alcohol in Robitussin®.

e. The concentration of alcohol in a shot of Johnnie Walker®.

f. The strength of a dilute potassium permanganate solution.

g. The concentration of mercury in Lake Erie.

h. The serum cholesterol concentration of a 60 year-old male.

i. The concentration of erythropoietin, a red cell growth factor.

j. The concentration of insulin.
Problem 15

Robert Roentgen, M.D.
100 W. Femur St
Bone View, NY. 14226

Name  Rexx Ray                   Date  10/1/95
Address 15 Battlecreek Rd, Warsaw, NY
Age 22  Height 160 cm  Weight 50 kg

Refill:

Barium sulfate  360g
Water qs ad.  360 ml

Dispense as written

Barium sulfate is an **insoluble** powder that is used by radiologists to image the gastrointestinal tract because it is opaque to x-rays.

a. If 1 ml of barium sulfate weighs 2.40 g, calculate the volume occupied by the barium sulfate.

b. What is the **volume** of water is required?

c. What is the total volume of the suspension?

d. How many **grams** of water are required?

e. What is the total weight of the suspension?
f. What is the barium sulfate % w/w?

____________________

g. What is the barium sulfate % v/v?

____________________

h. What is the barium sulfate % v/w?

____________________

i. What is the barium sulfate % w/v?

____________________

j. What is the barium sulfate concentration in mg/ml?

____________________

k. Which of the percent expressions is most likely to be used in practice for this situation?

____________________

l. Justify your answer to (j) above? Why is this so?

____________________
Problem 17

D. Glass, M.D.
100 N. Pyrex St
Buffalo, NY. 14226

Name: C. Corning
Age: 55
Weight: 220.5 lbs
Address: 15 Palace Rd, Lense, NY
Date: 17/8/95
Height: 160 cms

Rx
Benzalkonium chloride solution 120 ml
Make solution such that 2 teaspoonsful added to 1 L yields a 1:10,000 solution.
Sig: Add 2 teaspoonful to 1 liter with warm water and use as a soak.
Refill: ______

a. What is the benzalkonium chloride concentration applied?

b. What is the benzalkonium chloride concentration dispensed?

c. How much benzalkonium chloride is required?
Problem 41

You have a stock solution of penicillin G benzathine containing 300,000 units per ml. Penicillin G benzathine, a solid, has a potency of 1200 units/mg.

a. What volume of this stock solution should be injected?

b. What dose of penicillin G benzathine, in milligrams, has the patient received?

c. What is the concentration of Penicillin G benzathine in the stock vial in mg/ml?

d. Penicillin G benzathine is less active on a weight basis than its reference compound, Penicillin G. Do you expect the potency in µg/mg to be less than or greater than 1000 µg/mg?
Problem 43

a. What is the concentration of lactulose in mg/ml?

b. What is concentration of lactulose in % w/v?

c. What is the concentration of lactulose in grams/ml?

d. What is the concentration of lactulose in grams/liter?

e. What is concentration of lactulose in grains/fluid ounce?
Problem 69

Dr. Brittany Bassett, M.D.

<table>
<thead>
<tr>
<th>Name</th>
<th>Address</th>
<th>Age</th>
<th>Height</th>
</tr>
</thead>
<tbody>
<tr>
<td>Collie Boxer</td>
<td>8 Beagle Street, Mastiff</td>
<td>7yr</td>
<td>60 cm</td>
</tr>
</tbody>
</table>

**Rx** Sodium fluoride 200 ppm

Sig: Rinse mouth with 10 ml of solution bid after brushing

Disp: 0.5 liter bottle

B. Bassett, MD

Sodium fluoride is a solid.

a. What is the concentration of sodium fluoride in **percentage strength**?

b. What is the concentration of sodium fluoride in mg/ml?

c. What is the concentration of sodium fluoride in **parts or ratio strength**?

d. What is the concentration of sodium fluoride in **milligram percent**?

e. What is the concentration sodium fluoride in **grams/liter**?

f. What is the concentration sodium fluoride in **micrograms/ml**.
CHAPTER 6
CHEMICAL CALCULATIONS
NOTES

Outline
• Molecular weight, equivalents weights, composition and dosage
• Gases

Equivalent weight
• The equivalent weight of a chemical species is the number of grams required to chemically combine with 1 equivalent (1.008 g) of hydrogen or 1 equivalent of some other chemical species.
• The equivalent weight of an electrolyte is obtained by dividing the molecular weight by the total valence of either the anion or the cation. The water of hydration does not interfere with the calculations.

\[
\text{Equivalent Weight} = \frac{\text{Molecular Weight}}{\text{Valence}}
\]

• Equivalent weights are useful because all chemical compounds involve EQUAL numbers of equivalents of each chemical constituent. For example, \(x\) equivalents of calcium chloride contain \(x\) equivalents of chloride ion, and \(x\) equivalents of calcium ion. However, \(x\) moles of calcium will NOT yield \(x\) moles of calcium chloride, when reacted with \(x\) moles of chlorine, you get only \(x/2\) moles of calcium chloride because of the stoichiometry.

• Equivalent weights are useful because all chemical reactions involve EQUAL numbers of equivalents of each chemical species. All chemical compounds contain equal numbers of equivalents of the constituent species. For example, if \(x\) equivalents of calcium are reacted with \(x\) equivalents of chlorine, you will obtain \(x\) equivalents of calcium chloride. However, \(x\) moles of calcium will NOT yield \(x\) moles of calcium chloride, when reacted with \(x\) moles of chlorine.

• The concentration of electrolytes for parenteral solutions is frequently expressed in mEq/ml or milliequivalents per liter.

Calculating Molar Composition
• You may have to calculate molar (or equivalent) % composition given % w/w or %w/v. To do this, divide the %w/w of each ingredient by its molecular weight (or equivalent weight) to obtain the number of moles (or equivalents) of each species. Add these up to give you the total number of moles and obtain the % molar composition.

• To calculate % w/w or %w/v given molar (or equivalent) % composition, multiply the molar (or equivalent) % composition each ingredient by its molecular weight (or equivalent weight) to obtain the number of grams of each species. Add these up to give you the total number of grams and obtain the % molar composition.
Gases

- The ideal gas law is used for a wide variety of calculations with gases.

\[ PV = nRT \]

- Here, \( P, V \) and \( T \) are the pressure, volume and absolute temperature respectively. \( n \) is the number of moles and \( R \) is the gas constant.

- The units of pressure and volume must be consistent with the units of the gas constant. For example, if \( R = 8.314 \times 10^7 \) ergs °K \(^{-1} \) mol \(^{-1} \) is used, the value of \( P \) must be in dynes/cm \(^2\), \( V \) must be in cm \(^3\) and \( T \) in °K.

- If \( P \) is in atmospheres, volume is in liters, and \( T \) in °K, the gas constant \( R = 0.08205 \) liter atm °K \(^{-1} \) mol \(^{-1} \) must be used.

- Similarly, in SI units, where pressure is in newtons/m \(^2\), volume is in m \(^3\) and \( T \) in °K, the value of \( R = 8.314 \) Joules °K \(^{-1} \) mol \(^{-1} \).

- As consequence of Avogadro's principle, 1 mole of any (ideal) gas occupies 22.41 liters (or 22410 ml) at 273.15°K (0°C) and 1 atmosphere. This information is used to calculate the density and volumes of gases under any condition, via the ideal gas law.

- For a mixture of gases, the effective molecular weight can be taken to be the mole % weighted average of the molecular weight of the individual gases in the mixture. For example, if a gaseous mixture contains 95 mole % oxygen and 5 mole % carbon dioxide, the effective molecular weight is \((0.95 \times 32 + 0.05 \times 44) = 32.6\).

- At constant temperature, the partial pressure of a gas in gaseous mixture is a measure of gas concentration. This follows from Dalton's law of partial pressure which states that the total pressure of an ideal gas mixture is equal to the sum of the partial pressures.

\[ P = \text{Total pressure} = p_1 + p_2 + p_3 + p_4 + \ldots = \left(\frac{n}{V}\right)RT \]

\( p_1, p_2, p_3, p_4, \ldots \) are the partial pressures of the constituent gases.

If \( n_1, n_2, n_3, n_4, \ldots \) represent the number of moles of these constituent gases, then from the ideal gas law:

\[ p_1V = n_1RT \]

Similar equations can be written for the other constituents. Alternatively,

\[ \frac{p_i}{(RT)} = \left(\frac{n_i}{V}\right) \]

The \( (n_i/V) \) term represents the number of moles per unit volume or concentration. Therefore, at constant temperature, the partial pressure of a constituent is proportional to its concentration in a gas mixture.

- Similarly, for an ideal gas mixture, the mole percent of any constituent is identical to its % volume in volume.

Let \( v_1, v_2, v_3, v_4, \ldots \) represent the volumes occupied by the constituent gases. Remember, \((100 \ v_1/V), (100 \ v_2/V), (100 \ v_3/V), (100 \ v_4/V)\ldots\) are the % volume in volume. Because of the ideal gas law, we can also write

\[ P v_1 = n_1RT \text{ and } P v_2 = n_2RT \text{ and } P v_3 = n_3RT \text{ and } P v_4 = n_4RT \ldots \]
The USP formula for Ferrous sulfate syrup is:

- Ferrous Sulfate, $7\text{H}_2\text{O}$: 40
- Citric acid, $\text{H}_2\text{O}$: 2
- Sucrose: 825
- Water q.s. a.d.: 1000

The molecular weights of ferrous sulfate heptahydrate ($\text{FeSO}_4\cdot 7\text{H}_2\text{O}$), citric acid monohydrate and sucrose are 278, 210 and 342, respectively.

a. Rewrite the formula in terms of molarity.

b. Determine the number of milliequivalents of iron, sulfate and citrate per ml?

c. Determine the iron content in mg/ml of syrup?

d. What is the daily dose of iron received by Eva Adams?
Problem 16

Dr. Gale Monsoon, M.D.
Blizzard Ave, Cyclone City, FL

Name: Tempest Windstorm  Age: 65  Height: 160 cm
Address: Windy City Ave, Chicago  Date: 8/18/97  Weight: 85 kg

Sodium bicarbonate  420 mg
TD: 24 tabs. Sig: ii tab qid

This is a recipe for an antacid. Sodium bicarbonate (Na⁺(HCO₃)⁻) has a molecular weight of 84.

a. The Food and Drug Administration requires that each dose of an approved antacid contain at least 5 mEq of acid neutralizing power per dose. Does each tablet of this antacid meet this requirement? Show your reasoning.

b. The daily dose of sodium bicarbonate should not exceed 200 mEq/day in patients younger than 60 years and 100 mEq in patients over 60 years of age. Is this dose safe?

After a couple of days, your patient calls and complains of gastric distension and flatulence. After consulting the physician, you substitute the sodium bicarbonate with milk of magnesia, which is a suspension containing 290 mg of magnesium hydroxide (Mg₂⁺(OH⁻)₂, molecular weight 58) per 5 ml. Answer the following questions regarding the milk of magnesia regimen

c. What is the equivalent weight of magnesium hydroxide?

d. How many milliequivalents of magnesium hydroxide should be provided by the milk of magnesia in each dose?

Problem continues…
Problem continued

e. What dosing instructions would you give the patient regarding the milk of magnesia?

After a couple of days, your patient calls and now complains of laxative effects and diarrhea. After consulting the physician, you substitute the milk of magnesia with aluminum hydroxide tablets \((\text{Al}^{3+}(\text{OH}^-)_3\), molecular weight 78). Answer the following questions regarding the aluminum hydroxide tablets.

f. What is the valence of aluminum hydroxide?


g. You have capsules containing 475 mg or 500 mg, and tablets containing 300 mg or 600 mg aluminum hydroxide. Which dosage form provides the nearest dosage substitution?
Problem 18

Digoxin immune Fab is an antibody-derived protein drug that is administered for digoxin poisoning, a condition that is life threatening if not treated. 1 mg of Digoxin immune Fab binds 15µg of Digoxin.

a. Convert the concentration of diluted Digoxin Fab into mg/ml.

b. The dose of digoxin immune Fab is determined by the extent of the poisoning. This patient has consumed thirty five 0.2 mg capsules of digoxin. What is the minimum dose of digoxin immune Fab required for this patient?

c. Determine total volume of the 1:100 solution that must be infused.

d. One mole of the Fab binds exactly one mole of digoxin. If the molecular weight of digoxin is 781 grams/mole, determine the molecular weight of Digoxin immune Fab.
Deferoxamine mesylate is a chelating agent used as an antidote for lethal iron poisoning and chronic iron overloads in thalassemia and chronic anemia. Theoretically 1 g of deferoxamine mesylate reacts with 85 mg of ferric (Fe\(^{3+}\)) iron ions.

a. What is the valence of the Fe\(^{3+}\) iron ion?  

b. What are units of equivalent weight?  

c. What is the equivalent weight of Fe\(^{3+}\) iron ion?  

d. How many milligrams of Fe\(^{3+}\) iron ion can the dose of deferoxamine mesylate theoretically neutralize?  

e. How many milliequivalents of Fe\(^{3+}\) iron ions are present in 85 mg of Fe\(^{3+}\) iron ions?  

f. Calculate the equivalent weight of desferoxamine mesylate.
### Problem 41

**Dr. Yasmin Cade, M.D.**

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<tr>
<td>Address</td>
<td>Date</td>
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<tr>
<td>8 Vinessa Ave, Dylanville</td>
<td>8/18/02</td>
<td>100 kg</td>
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**Rx**

Diatrizoate meglumine 60% w/v
Administer 10 ml in left knee joint. Obtain images within 15 min

This is a drug that is used as an x-ray contrast agent. Diatrizoate meglumine is an effective contrast agent because it contains iodine. **Pure** diatrizoate meglumine contains 47.06% w/v iodine.

a. What is the **iodine** concentration in the solution dispensed in the prescription?

b. What is the **iodine** dose?

c. Each molecule of diatrizoate meglumine three atoms of iodine. What is the molecular weight of diatrizoate meglumine?

d. What is the concentration of the diatrizoate meglumine solution injected in molarity?
Molecular weights of reactants:

- Magnesium hydroxide: $Mg^2+(OH)_2$
- Aluminium hydroxide: $Al^{3+}(OH)_3$

a. What is the equivalent weight of magnesium hydroxide?

b. What is the equivalent weight of aluminum hydroxide?

c. How many milliequivalents of magnesium ion are present in each tablet?

d. How many milliequivalents of aluminium ion are present in each tablet?

e. How many milliequivalents of hydroxide ion are present in each tablet?

f. Both magnesium hydroxide and aluminum hydroxide react with stomach acid. Assuming stomach acid is hydrochloric acid (HCl), determine the mass of hydrochloric acid neutralized by a single tablet.
Problem 48

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<td>144 Yasmin St, Kobyville</td>
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Ammoniated mercury topical lotion 5% w/v
AAA psoriasis bid

**Refill**

Barbie Ken, M.D.

Pure ammoniated mercury (\(Hg(NH_2)Cl\)) or mercury amide chloride is a powder and has a molecular weight of 252 and has bacteriostatic activity.

a. What is the **mercury** content of **PURE** ammoniated mercury powder in **grams/gram**?

b. What is the **mercury** content of **PURE** ammoniated mercury powder in **percent w/w**?

c. Express the concentration of **ammoniated mercury** in the **lotion** in grams/liter.

d. Express the concentration of **ammoniated mercury** in the **lotion** in molarity.

e. Express the concentration of **mercury** in the **lotion** in molarity.

f. Express the concentration of **mercury** in the **lotion** in mg/ml.
Problem 51

Dr. Daphne Blake-Rogers
12 Scoobyville St., Norville, TX 10210

Name: Velma Dinkley-Jones  Age: 23  Wt: 80 kg
Address: 144 Freddy St, Norville  Date: 1/10/95  Height: 5 ft 10 in

Omalizumab 150 mg dissolved in 1.2 ml of reconstitution solution
150 mg sc q2 weeks

Daphne Blake, M.D.

Omalizumab is a monoclonal antibody used to treat asthma. It reduces the allergic responses that can trigger asthma attacks. Omalizumab has two binding sites for immunoglobulin E, an immunoglobulin that mediates allergies. One molecule of reacts with 2 molecules of immunoglobulin E, i.e. the valence of omalizumab is 2.

The molecular weight of omalizumab is 150,000 grams/mole and the molecular weight of immunoglobulin E is 190,000 grams/mole.

a. Calculate the concentration of omalizumab in mg/ml.

b. Calculate the concentration of omalizumab in millimoles/ml?

c. Express the concentration of omalizumab in nanomoles/ml.

d. Express the concentration of omalizumab in mEq/ml.

e. How many milligrams of immunoglobulin E will a single dose of omalizumab neutralize.
Problem 52

Dr. Brie Romano
12 Ricotta St., Cheddar,
WI 80210

DEA# BR -12736280

Name
Mozzarella Roquefort

Address
144 Gouda St, Cheddar, WI

Age
24

Date
1/21/06

Height
5 ft 10 in

Weight
120 kg

Rx
Potassium citrate tablets 10 mEq
DTD #30. Two tablet tid pc

Potassium citrate \((K^+\left(C_6H_5O_7\right)^{3-})\) has a molecular weight of 306 and is used to as a urinary alkalinizer in patients with kidney stones.

a. What is the valence of potassium citrate?

b. What is the equivalent weight of potassium citrate.

c. What is the potassium ion content of each tablet in millequivalents.

d. Calculate the potassium content in each tablet in milligrams.

e. Calculate the mass of potassium citrate in each tablet in milligrams.

f. Potassium citrate is converted via the biochemical processes to potassium bicarbonate \((K^+(HCO_3))^-\), which is responsible for urine alkalinization. Calculate the milligrams of potassium bicarbonate formed from each tablet.
Problem 53

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<th>Name</th>
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Rx
Sodium fluoride solution containing 0.09% w/v fluoride ion
Dispense 100 ml
Rinse 10ml solution over sensitized teeth for 1 minute, spit out qhs after brushing

The formula for sodium fluoride is Na<sup>+</sup>F<sup>-</sup>.

a. Calculate the concentration of fluoride ion in the solution in mg/ml?

b. Calculate the concentration of sodium fluoride in the solution in mg/ml?

c. Calculate the concentration of sodium ion in the solution in mg/ml?

d. Calculate the sodium fluoride concentration in ppm?

e. Calculate the sodium fluoride concentration in mmoles/ml?

f. Calculate the sodium fluoride concentration in mEq/ml?
Problem 61

Kay Speciale, DDS
101 Cereal St.
Flakes, KS

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Nitrous oxide 60% v/v and 40% v/v oxygen for dental anesthesia

Kay Speciale M.D.

Nitrous oxide (N₂O) is a gas that is sometimes used as a general anesthetic in dentistry and as an analgesic in obstetrics. It produces only light anesthesia but is rapid acting. To avoid damage to the central nervous system it must be used with oxygen.

a. Calculate the concentration of nitrous oxide in mole%.

b. Calculate the molecular weight of the mixture.

c. Determine the weight (in grams) of 22.41 liters of the gas mixture at 0°C and 1 atmosphere pressure.
CHAPTER 7
INFUSIONS
NOTES

INFUSIONS

- Infusions are dosing regimens in which the drug is continuously administered to a patient.
- Infusions are usually administered intravenously, although oral and transdermal infusion routes may be appropriate for certain drugs. Infusions are more common in hospital settings.
- The mathematics of infusions is very similar to that of discrete dosing. The apparent complexity is caused by the introduction of an additional variable, time.
- The other factor contributing to the apparent complexity of infusion calculations is that infused drugs are always administered in a solution such as D5W, normal saline.
- You should distinguish between intravenous bolus or intravenous push administration and intravenous infusions.
- You must distinguish between drug flow rate and infusion flow rate.
- Here are the equations for calculating drug dosage for infusions.

\[
\text{Drug dose} = \text{Drug flow rate} \times \text{Time} \\
\text{Drug flow rate} = \text{Infusion flow rate} \times \text{Drug concentration}
\]
Sodium nitroprusside is an extremely potent antihypertensive agent used for cardiac emergencies. Because of its extreme potency, it must be prepared in exact concentrations and administered at carefully controlled rates. Effective infusion rates range from 0.5 – 8 µg/kg/minute.

a. Sodium nitroprusside is supplied as a 50 mg lyophilized powder that is reconstituted in 500 ml D5W before use. What is the concentration of drug in the infusion medium?

b. What is the initial drug dosing rate in mg/min?

c. What is the initial infusion rate in ml/min?

d. If the patient does not respond to the treatment at the initial dose, what action would you take?

e. Calculate the new infusion rate in ml/min and the drug dosing rate in mg/min?
Problem 7

Dr. Beverly Crusher
Sickbay Street, Enterprise, NY 14002

Phone 716-555-1234         DEA# BC - 12736280

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<tr>
<th>Name</th>
<th>Jean-Luc Picard</th>
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Cimetidine hydrochloride in NS. Inject 150 mg IV bolus loading dose stat. Followed with IV infusion at 40 mg/hour until 160 mg of drug is infused.

B. Crusher, MD

a. You have two solutions of cimetidine hydrochloride in NS. One solution contains 150 mg/ml drug and the other contains 6 mg/ml of drug. Which of the two solutions would you prefer for the IV bolus?

b. What is drug flow rate per minute?

c. After how long should the drug infusion be stopped?

d. You are using the 6 mg/ml cimetidine product for the infusion. Calculate the infusion flow rate.

e. You are using an infusion device with a drop factor 60 gtt = 1 ml. What drop rate should the device be set at?
Co-trimoxazole is a combination of TWO antibiotic drugs trimethoprim and sulfamethoxazole. The combination is more potent than either drug alone. The parenteral concentrate contains 16 mg/ml trimethoprim and 80 mg/ml sulfamethoxazole. Co-trimoxazole dosage is expressed in terms of trimethoprim content.

a. What dose sulfamethoxazole does the patient receive in \( \text{mg/(kg day)} \)?

b. What is the concentration of trimethoprim in the infusate? Don’t ignore the added concentrate volume.

c. What is the flow rate of trimethoprim?

d. What is the infusion flow rate?

e. How much is a single dose of trimethoprim?

f. How much \( \text{D5W} \) is required for a single dose?
**Problem 11**

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Infuse i.v. 5 mcg/min 100 mcg/ml Nitroglycerin in D5W for 5 minutes followed by 10 mcg/min for 10 min, followed by 20 mcg/min for 10 min.

E. Adams, MD

Nitroglycerin is a cardiac drug used to treat angina.

a. What is the initial flow rate of infusion fluid in ml/min?

b. How would you increase the drug flow rate to 10 mcg/min?

c. What should the infusion fluid flow rate be 20 minutes after the start of the first infusion?

d. What is the total dose received by the patient?

e. What would the drug flow rate be if the infusion flow rate were set at 0.25 ml/min?
Problem 17

Phone 555-3784

Kitty Litter
Diaper, NY 14210

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RX

Nitroglycerin 100 mcg/ml in D5W by iv infusion Set initial dosing rate at 5 mcg/min. Increase by 5 mcg/min q5 min until blood pressure responds

Kitty Litter M.D.

a. What is the concentration of nitroglycerin in the infusion fluid in mg/ml?

b. What is the initial infusion flow rate?

c. What is the drug dosing rate if the patient’s blood pressure does not respond in 5 minutes.

d. How would you go about changing the drug dosing rate to the level in (c)?

e. What is the total dose of nitroglycerin at 10 minutes?
Fludarabine phosphate 25 mg/m² by IV infusion over 30 minutes for chronic lymphocytic leukemia. Repeat each day for consecutive 5 days. Reconstitute fludarabine phosphate to obtain 25 mg/ml parenteral concentrate. Add 2 ml of parenteral concentrate to 125 ml D5W. Infuse.

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a. What is the patient’s body surface area?  

b. Calculate the concentration of fludarabine phosphate in the infusion fluid in **mg/ml**?

c. What is the single dose of fludarabine phosphate?

d. Calculate the drug flow rate.

e. Calculate the infusion flow rate.

f. Calculate the volume of infusion fluid used up.
Problem 29

Phone 555-3784

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Trastuzumab (Herceptin) loading dose 6 mg/kg IV over 90 min qw for 3 week. Maintenance 4 mg/kg over 30 min q3w for 6 cycles. Add required volume of 21 mg/ml drug solution to 250 ml NS IV bag. Infuse iv ut dict

Joy Fina M.D.

a. What is the concentration of trastuzumab in the infusion fluid for the loading dose?

b. What is the drug flow rate during a loading dose?

c. What is the infusion flow rate?

d. What is the total dose in the entire chemotherapeutic regimen?
Problem 31

Dr. Jerboa Capybara, M.D.
3 Pacarana Ave
Zokor, AL

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**R** Dopamine hydrochloride 5 µg/kg/min D5W IV stat.
Increase dose in increments of 5 µg/kg/min q 30 minutes until desired BP is achieved. Do not exceed 25 µg/kg/min.

J. Capybara, MD

---

a. For intravenous injection, vials containing 200 mg dopamine hydrochloride are reconstituted in 500 ml of 5% dextrose in water. Determine the dopamine hydrochloride concentration after reconstitution?

b. What is the initial drug flow rate?

c. What is the initial infusion flow rate in ml/min?

d. What is the infusion flow rate (ml/min) at the maximum allowable dose?
Problem 32

Cupid Heart Institute
101 Venus St., Cherub, NY 14210

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Address
Lard St, Coronary, NY 12205

Date 2/4/96
Height 170 cm

Lidocaine HCl. IV Bolus at 1.25 mg/kg stat.
Maintenance infusion 25 mcg/(kg min) for 2 1/2 hrs

Aorta Venacava M.D.

A monograph on lidocaine hydrochloride is attached. As the attending pharmacist, you have of 20% lidocaine hydrochloride injection available.

a. Is the maintenance infusion within the normal dosage range?

b. How would you prepare the infusion fluid for the maintenance infusion?

c. What flow rate should the maintenance infusion be set at?

d. How much lidocaine would be dosed in 2.5 hours?

e. Now consider the total regimen. Is the treatment safe?
Minimum Weighable Quantity

- The sensitivity requirement of a balance is the minimum weight that will shift the pointer in a balance by a division.
- The sensitivity requirement of Class A balances used in pharmacy is 6 mg or better.
- Any weight less than the sensitivity requirement cannot be measured with any accuracy.
- It DOES NOT mean that as a pharmacist you should ever try to measure 6 mg! Why?

\[
\text{Fractional Error} = \frac{\text{Sensitivity Requirement}}{\text{Amount Weighed}}
\]

- As a pharmacist, **your error must be less than 5%**.
- Calculate the minimum weighable quantity from the above formula.

\[
\text{Minimum Weighable Quantity} = \frac{\text{Sensitivity Requirement}}{\text{Maximum Fractional Error Acceptable}}
\]

- NEVER weigh less than **120 mg** on a prescription balance!

Principles For Solving Minimum Weighable Quantity Problems

- You have to solve the problems so that you NEVER weigh less than **120 mg**.
- First, a quantity of drug equal or greater than the minimum weighable quantity is weighed.
- The drug is diluted in an appropriate amount of inert diluent such as lactose. Be sure to mix well.
- An aliquot of the diluted mixture which contains the required amount of drug is weighed. This aliquot should also be equal or greater than the minimum weighable quantity.
- To solve minimum weighable quantity problems, the strategy used is:

\[
\text{Concentration of Drug in Diluted Mixture} = \frac{\text{Concentration of Drug in Aliquot}}{\text{Concentration of Drug in Aliquot}}
\]

- Since \(\text{Concentration of Drug in a Mixture} = \frac{\text{Amount of Drug}}{\text{Total Quantity of Mixture}}\)
- We can rewrite the principle in mathematical terms as:

\[
\frac{\text{Amount of Drug in Diluted Mixture}}{\text{Amount of Drug} + \text{Amount of Diluent}} = \frac{\text{Amount of Drug in Aliquot}}{\text{Total Quantity of Aliquot}}
\]

- The amount of drug in the aliquot is known from the prescription.
- The amount of drug in the diluted mixture is set to a value equal to or greater than the minimum weighable quantity.
- Similarly, the total quantity of the aliquot is also set to a value equal to or greater than the minimum weighable quantity.
- Using algebra, the amount of diluent required is easily calculated.
**Problem 2**

a. You are making volumetric measurements in a 10 ml capacity graduated measuring cylinder that is marked every 0.1 ml. What is the minimum volume you should measure in the cylinder to ensure that the percent error is 5% or less.

____________________

b. You have a bathroom scale that is has a sensitivity requirement of 1 pound. You decide to use it to measure the weight of your child and want your measurement error to be 2.5% or less. How much should your child weigh (in pounds) in order for this to be feasible?

____________________

c. You own two balances, affectionately named Click and Clack by the interns. Click has a sensitivity requirement of 1.5 mg while Clack has a sensitivity requirement of 2.7 mg. Which balance is more sensitive?

____________________

d. What values of sensitivity requirement and percent error are assumed in arriving at the “conventional” minimum weighable quantity of 120 mg?

____________________

e. Suppose that balance quality has improved by the time you begin practicing as a registered pharmacist. Determine the minimum weighable quantity if the sensitivity requirement is 2.5 mg and maximum tolerable error is ± 1.25%

____________________

f. You have a prescription balance with a sensitivity requirement of 8 mg. What is the minimum weighable quantity if you wanted to keep errors to 2.5% or less?

____________________
Problem 4

Bartholomew Simpson
102 Fox St., Springfield, IL 14003

<table>
<thead>
<tr>
<th>Name</th>
<th>George Papsmear</th>
</tr>
</thead>
<tbody>
<tr>
<td>Address</td>
<td>Rorschasch Ave, Therapi, IL 90210</td>
</tr>
<tr>
<td>Age</td>
<td>47</td>
</tr>
<tr>
<td>Date</td>
<td>1/10/95</td>
</tr>
<tr>
<td>Atropine Sulfate</td>
<td>200 mcg</td>
</tr>
<tr>
<td>Phenobarbital</td>
<td>16 mg</td>
</tr>
<tr>
<td>Lactose qs ad.</td>
<td>120 mg</td>
</tr>
<tr>
<td>M ft caps DTD #60. Sig: ii caps qid.</td>
<td></td>
</tr>
</tbody>
</table>

a. How many milligrams of lactose are present per capsule?

b. You weigh out the minimum weighable quantity of atropine sulfate consistent with a sensitivity requirement of 6 mg and an error of 5%. How much atropine sulfate would you weigh out?

c. You mix the minimum weighable quantity of atropine sulfate from (b) above with 2 g of lactose and triturate. You now want to create an aliquot of the triturated mixture containing the exact amount of atropine sulfate for all 60 capsules. What is the weight of this aliquot?

d. You mix the phenobarbital required for the 60 capsules into the atropine sulfate-containing aliquot in (c). How much phenobarbital would you add?

e. You then add the remaining lactose needed for 60 capsules into the atropine sulfate and phenobarbital-containing aliquot in (d). How much lactose would you add?
Problem 5

Dr. Margarita Whisky
Champagne, IL 14002

<table>
<thead>
<tr>
<th>Name</th>
<th>Age</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brandy Apertif</td>
<td>63</td>
<td>9/28/97</td>
</tr>
</tbody>
</table>

Address
13 Cordial Rd, Champagne

Prednisone
Lactose qs
DTD 24 caps
Sig: 5 mg/day in two doses

2.5 mg
150 mg

a. What instructions would you give your patient?

b. What is the minimum amount of prednisone that should be weighed out? State your sensitivity requirement and percent error assumptions.

c. Assume you have weighed out 125 mg of prednisone. How much lactose should be added?

d. How many excess capsules will have you after dispensing the prescription. Assume you used the 125 mg prednisone weighed out in (c) above?

e. If you balance has a sensitivity requirement of 5 mg, what is the percent error associated with a 150 mg weight measurement?

Problem continues on next page
Dr. Etha Noll  
Champagne, IL 14002

<table>
<thead>
<tr>
<th>Name</th>
<th>Age</th>
<th>Weight</th>
<th>Height</th>
</tr>
</thead>
<tbody>
<tr>
<td>Al Cojol</td>
<td>9</td>
<td>30 kg</td>
<td>4 ft</td>
</tr>
</tbody>
</table>

Address: 13 Sherry Rd, Champagne

Date: 9/28/97

Prednisone  
m ft SA 24 caps  
Sig: 250 mcg/(kg day) tid

qs  
E. Noll.

f. Can the excess product prepared for Brandy Apertif be dispensed to young Al Cojol?

______

g. Does the minimum weighable quantity increase or decrease when the sensitivity requirement increases?

______

h. The pharmacist managing your pharmacy decides on January 1, that she wants to set a new standard for maximum percent error. The new percent error is 3%. Replacing the working Class A prescription balances in the pharmacy is not an option. What would you do to help her fulfil her New Year’s resolution?

______
Problem (continued)

After weighing out the minimum weighable quantity of atropine sulfate, you decide to use all the atropine sulfate weighed to make a stock bottle containing capsules according to the above formula. Soon afterwards, you are asked to attend to the following prescription from Dr. John Sartre.

<table>
<thead>
<tr>
<th>Name</th>
<th>Address</th>
<th>Age</th>
<th>Height</th>
<th>Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Margaret Bundy</td>
<td>25 State St, Buffalo, NY</td>
<td>44 yo</td>
<td>160 cm</td>
<td>80 kg</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Rx</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Atropine sulfate</td>
<td>0.0064g</td>
</tr>
<tr>
<td>Phenobarbital</td>
<td>0.24 g</td>
</tr>
<tr>
<td>Lactose q.s. SA</td>
<td></td>
</tr>
<tr>
<td>div. caps #16</td>
<td></td>
</tr>
<tr>
<td>Sig: i q6h</td>
<td></td>
</tr>
</tbody>
</table>

e. Could you dispense the previously compounded capsules to Margaret Bundy? Justify your answer with calculations.
Problem 12

Dr. Billy Rubin, M.D.
3 Porphyrin Lane, Glucuronide, CO

<table>
<thead>
<tr>
<th>Name</th>
<th>Age</th>
<th>Height</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jon Dice</td>
<td>45 yr</td>
<td>5 ft 8 in</td>
</tr>
</tbody>
</table>

Address                  Date          Weight       
87 Melanin Lane          8/18/97        100 kg

Drugs:
- Reserpine 0.1 mg
- Trichlormethiazide 2 mg
- Lactose qs ad 150 mg
- DTD #30. Sig i tab bid for bp

R

a. How much reserpine is required for all the doses in this prescription if you compound without any knowledge of measurement errors?


b. How much trichlormethiazide is required for all the doses in this prescription if you compound without any knowledge of measurement errors?


c. You decide to first weigh 120 mg of trichlormethiazide and mix it thoroughly (triturate) with 480 mg of lactose. Determine the mass of the aliquot that contains the trichlormethiazide required for all the doses.


d. You decide to weigh 120 mg of reserpine and mix it thoroughly (triturate) with 5880 mg of lactose. Determine the mass of the aliquot that contains the reserpine required for all the doses.


e. You decide to mix appropriate aliquots of the preparations from part (d) and part (e) together and qs with additional lactose. How much additional lactose is required for all the doses?


Problem 15

Dr. Max Power, M.D.
DEA# AT-12736280

<table>
<thead>
<tr>
<th>Name</th>
<th>M. Simpson</th>
<th>Age</th>
<th>52 yr</th>
<th>Height</th>
<th>6 ft 2 in</th>
<th>Weight</th>
<th>100 kg</th>
</tr>
</thead>
<tbody>
<tr>
<td>Address</td>
<td>Evergreen Terr, Springfield</td>
<td>Date</td>
<td>8/18/04</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Rx

Esterified estrogen 0.4 mg
Methyltestosterone 1.25 mg
Lactose qs ad 200 mg
DTD#21. Sig 1 cap qd for 21 days

You have a prescription balance with a sensitivity requirement of 6 mg and always aim for a measurement error of 5% or less.

a. How much methyltestosterone would be required if you were to compound this prescription without any knowledge of minimum weighable quantity?

b. In the first step, you decide to weigh 120 mg of esterified estrogen and mix it with 2380 mg of lactose. What is the mass of the aliquot that contains the exact amount of esterified estrogen required for all the capsules?

c. In the next step, you decide to weigh 120 mg of methyltestosterone and mix it with 1000 mg of lactose. What is the mass of the aliquot that contains the exact amount of methyltestosterone required for all the capsules?

d. In the final step, you decide to mix the aliquots (from part c and part d) containing the required amounts of esterified estrogen and methyltestosterone and add a calculated amount of lactose to make a mixture containing material for compounding all the capsules. How additional lactose must be added at this step?

e. What is the concentration of esterified estrogen in each capsule in percent w/w?
CHAPTER 9
DILUTION AND RECONSTITUTION
NOTES

Outline

• Dilution and Concentration: The two golden rules
• Alligation medial and alligation alternate
• Serial dilution
• Reconstitution

Dilution, Concentration And Mixtures

• In dilution problems only one ingredient brings in drug, the other is a diluent or solvent that does not contain any drug. In concentration problems, the solvent, usually water, is selectively removed, e.g., by evaporation. In mixture, two or more ingredients contain drug.

Dilution and Concentration: The Two Golden Rules

• All dilution and concentration problems can be solved by remembering only two simple principles:
• Amount = Concentration \times\text{Quantity}
• Law of conservation of mass.
• Together, these two principles yield the formula:

\[ A = C_1 Q_1 = C_2 Q_2 \]

• Remember to keep track of units. The units of concentration must be the same on both sides of the equation and units of quantity must be consistent with the units in the denominator of concentration. The units of amount will then be consistent with the units of the numerator of concentration. For example, if the units of concentration are mass/volume, then the units of quantity must be expressed in terms of volume to give amounts in units of mass.

Mixture Problems and Alligation

• Alligation is a fancy name for a calculation method that simplifies certain kinds of mixture problems. It is simply a useful extension of the two golden rules and can be used to solve the following two classes of mixture problems:

Problem Class I: Alligation Medial

• To determine the composition of the product when known quantities of two or more preparations of known composition are mixed. The method involves determining the weighted average composition and is called alligation medial.

• Example: 200 g of 10% w/w, 50 g of 20% w/w and 100 g of 5% w/w zinc oxide ointments are mixed. Determine the composition of the resulting mixture.

<table>
<thead>
<tr>
<th>Concentration</th>
<th>Quantity, g</th>
<th>Amount of ZnO, g</th>
</tr>
</thead>
<tbody>
<tr>
<td>10 % w/w</td>
<td>0.1 g/g</td>
<td>200</td>
</tr>
<tr>
<td>20% w/w</td>
<td>0.2 g/g</td>
<td>50</td>
</tr>
<tr>
<td>5% w/w</td>
<td>0.05 g/g</td>
<td>100</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>350</strong></td>
<td><strong>35</strong></td>
</tr>
</tbody>
</table>
\[(C_{Product} - C_1)Q_1 = (C_2 - C_{Product})Q_2\]

\[
\frac{Q_1}{Q_2} = \frac{C_2 - C_{Product}}{C_{Product} - C_1}
\]

- This means that the relative ratio of the quantities required is inversely proportional to the ratio of the differences in concentration. Since the relative ratios are known, the quantity of each preparation can be calculated.

- Alligation methods assume that the quantities involved are additive. You cannot therefore use alligation methods for volume calculations in which considerable expansion or contraction occurs upon mixing unless the final product is "qs-ed" with one of the liquid components. However, you can always use the approach when quantities are expressed in mass units because the law of conservation of mass always holds true.

**Serial Dilutions**

- Serial dilution is the repeated usage of a particular dilution procedure. See Figure 9.1.

- Serial dilutions are an accurate method of making solutions of low concentrations by performing a series of dilutions to rapidly reduce the concentrated solution that is given.

- Serial dilutions are frequently used when direct one-step dilution would require very large volumes of diluent. Large volume measuring devices may sometimes not be available. Large one-step dilutions are inefficient because they use large quantities of diluents and consequently generate large volumes of waste for disposal.

- Serial dilutions are sometimes necessary because of the constraints imposed by minimum weighable quantity: e.g., A pharmacist may need to use 0.1 mL solution containing 100,000 units/mL drug A to prepare a desired 100-mL solution containing 10 units/mL drug A. Given a minimum measurable volume of 1.0 mL, the pharmacist should NOT carry out single dilution by measuring 0.1 mL of the original solution. The pharmacist may

---

**Figure 9.1.** Schematic for a 1: 10,000 serial dilution. Ten ml of a 0.01% solution is obtained from 100% stock using 4 steps.
Problem 3

Rosemary Oregano  
101 Basil St.  
Cayenne, WY

<table>
<thead>
<tr>
<th>Name</th>
<th>Ginger Cumin</th>
<th>Age</th>
<th>Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Address</td>
<td>Peppertree Ave, Cayenne, WY</td>
<td>32</td>
<td>50 kg</td>
</tr>
</tbody>
</table>

Add 5 ml of parenteral concentrate containing 16 mg/ml trimethoprim and 80 mg/ml sulfamethoxazole to 75 ml of D5W. Infuse mixture IV over 1 hour.

R. Oregano  M.D.

Sulfamethoxazole and trimethoprim are used in combination because the mixture is a more effective antibacterial than either drug alone. A parenteral concentrate containing both drugs in aqueous solution is commercially available. The concentrate is diluted before IV infusion.

a. What is the concentration of sulfamethoxazole in the concentrate in % w/v?

b. Determine the total volume of the diluted mixture. Assume that there is no expansion or contraction upon dilution.

c. Determine the concentration of sulfamethoxazole in the diluted mixture in mg/ml.

d. Determine the total dose of sulfamethoxazole in mg.

e. Calculate the infusion flow rate in ml/min.
Problem 9

**Cory Blackfin**  
12 Puffer St., Danio, AK 50210

<table>
<thead>
<tr>
<th>Name</th>
<th>Age</th>
<th>Height</th>
</tr>
</thead>
<tbody>
<tr>
<td>Piranha Black</td>
<td>23 yr</td>
<td>5 ft 10 in</td>
</tr>
<tr>
<td>Address</td>
<td>Date</td>
<td>Weight</td>
</tr>
<tr>
<td>1448 Crystal Tetra Ct, Danio</td>
<td>1/21/05</td>
<td>80 kg</td>
</tr>
</tbody>
</table>

**R** Infuse 200 mg ciprofloxacin by IV infusion over 60 minutes q12 hour. Prepare a 1.5 mg/ml infusion solution by adding 10 mg/ml ciprofloxacin lactate parenteral concentrate solution to 250 ml D5W.

a. How much ciprofloxacin lactate parenteral concentrate should be added. Do not neglect the volume of the added concentrate?

b. Calculate the volume of infusion fluid that must be infused.

c. A new nurse inadvertently adds 60 ml of ciprofloxacin lactate parenteral concentrate to a 250 ml D5W infusion bag. Calculate the concentration in the infusion fluid.

d. Assume that a supervisor detected this error prior to the start of the infusion. Calculate the volume of the infusion fluid from part (d) that when infused would provide the prescribed dose.

e. Now assume that the nurse’s error was not detected until the infusion was running for 30 minutes at a flow rate of 2.217 ml/min. The erroneously prepared infusion fluid from part (d) was allowed to continue to run at the infusion flow rate of 2.217 ml/min. However, the infusion was terminated when the full ciprofloxacin dose was administered. Calculate the total time for which this infusion was run.
Problem 10

<table>
<thead>
<tr>
<th>Phone 867-654-3210</th>
<th>Joshua Tree Cuyahoga Valley, OH</th>
<th>DEA #AA9124366</th>
</tr>
</thead>
<tbody>
<tr>
<td>Name</td>
<td>Age 21</td>
<td>Weight 50 kg</td>
</tr>
<tr>
<td>Address</td>
<td>Date 10/10/05</td>
<td>Height 160 cm</td>
</tr>
<tr>
<td>Wind Cave Ave, Yellowstone, MT</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Diatrizoate meglumine solution  qs.
Diatrizoate sodium solution  qs.
M and ft. 100 ml of a solution containing 290 mg/ml of iodine.

This product is for a contrast agent that is effective because it contains iodine, which confers opacity to x-rays. Diatrizoate meglumine solution contains 282 mg/ml iodine. Diatrizoate sodium solution contains 300 mg/ml iodine.

a. Express the iodine concentration of **diatrizoate meglumine** solution in % weight in volume.

b. **Set up** for determining the quantity of diatrizoate meglumine solution using the **alligation alternate** approach, i.e., Fill in the **double underlined blanks** in the table below.

\[
\begin{array}{c|c|c}
\hline
\text{Iodine mg/ml} & \text{Volume ml} & \text{Percentage} \\
\hline
282 & & \\
300 & & \\
290 & & \\
\hline
\end{array}
\]

c. What volume of **diatrizoate meglumine** is required for filling the prescription?

d. What volume of **diatrizoate sodium** is required for filling the prescription?
Problem 14

Barbie Ninja-Turtle
Teletubby, GA 470001

<table>
<thead>
<tr>
<th>Name</th>
<th>Address</th>
<th>Age</th>
<th>Weight</th>
<th>Height</th>
</tr>
</thead>
<tbody>
<tr>
<td>Elmo Barney</td>
<td>8 Ken Street, Teletubby, GA</td>
<td>40</td>
<td>100 kg</td>
<td>5’ 8”</td>
</tr>
</tbody>
</table>

Potassium chloride, KCl or K\(^+\)Cl\(^-\), has a molecular weight of 75. Potassium bicarbonate, KHCO\(_3\) or K\(^+\)(HCO\(_3\))\(^-\), has a molecular weight of 100. Potassium citrate K\(_3\)^+(C\(_6\)H\(_5\)O\(_7\))^3^- has a molecular weight of 324. Potassium has an atomic weight of 39.

a. What is the equivalent weight of potassium citrate?

b. The units for amounts of the various potassium salts are not indicated in the prescription. If all the salts are solids at room temperature, what units are implied?

c. How many mEq of potassium ions are contributed to each dose by the potassium chloride?

d. How many mg of potassium ions are contributed to each dose by the potassium chloride?

e. How many mEq of potassium ions are present in each dose?
Problem 15

R. Enema
Emetic, IA 14002

Name | Age | Weight | Address | Date | Height
--- | --- | --- | --- | --- | ---
Ann Algesia | 30 | 80 kg | Astringent Street, Emetic, IA | 9/23/97 | 5’ 8”

Transfuse 2 units of Type AB or Type O whole blood stat

R Enema  M.D

A unit of whole blood is 500 ml.

a. Calculate the volume of blood transfused.

b. The concentration of red cells, often referred to as hematocrit, in the infused whole blood is 45% v/v. Calculate the volume of the infused red cells.

c. The patient is hypovolemic (i.e., she has low blood volume) and anemic (i.e., she has a low red cell count). Assume that the patient blood volume is 3500 ml and her hematocrit 30% v/v. Estimate the volume of red cells in the patient before the transfusion.

d. Estimate the hematocrit immediately after the transfusion is complete.

e. How many ml of blood would be required if the physician wanted to attain a final hematocrit of 35% v/v. Again assume that the patient has a blood volume of 3500 ml and a hematocrit of 30%; and that the transfused blood has a hematocrit of 45%.
Problem 17

Dr. H. Mustard-Dressing
Thousand Island, PA 14002

<table>
<thead>
<tr>
<th>Name</th>
<th>Cesar French</th>
<th>Age</th>
<th>9</th>
<th>Weight</th>
<th>30 kg</th>
</tr>
</thead>
<tbody>
<tr>
<td>Address</td>
<td>13 Ranch Rd, T.I.</td>
<td>Date</td>
<td>9/28/97</td>
<td>Height</td>
<td>4 ft</td>
</tr>
</tbody>
</table>

Potassium chloride qs
Potassium gluconate qs
Water qs ad 100 ml
m ft SA solution containing 1 mEq Cl– and a total of
7 mEq K+ per 5 ml.
Sig: 21 mEq K+ per day in three equal doses

This is a formula for an oral potassium supplement. Here is some additional information:
Potassium chloride (K+Cl–, molecular weight 74.5); potassium gluconate (K+ (C6H11O7)–, molecular weight 234), potassium has an atomic weight of 39.

a. What instructions would you give the patient

b. What is the potassium chloride concentration in mEq/teaspoonful?

c. What is the potassium chloride concentration in mg/teaspoonful?

d. What is the potassium gluconate concentration in mEq/teaspoonful?

e. What is the potassium gluconate concentration in mg/teaspoonful?
Problem 21

Dr. Jade Diamond, M.D.
3 Ruby Ave, Coralville, IA

Phone 716-555-1234
DEA# AD -12736280

<table>
<thead>
<tr>
<th>Name</th>
<th>Pearl Crystal</th>
<th>Age</th>
<th>Height</th>
</tr>
</thead>
<tbody>
<tr>
<td>Address</td>
<td>Sapphire Street, Coralville</td>
<td>28</td>
<td>5 ft 8”</td>
</tr>
<tr>
<td>Date</td>
<td>6/19/07</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Weight</td>
<td>76 kg</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

1.1 mg/ml sodium fluoride solution qs
4.4 mg/ml sodium fluoride solution qsad 100 ml
m ft solution containing 0.2% NaF

Sodium fluoride (NaF, Molecular weight 42) is used to prevent cavities in teeth.

a. What is concentration of sodium fluoride in the product in mg/ml?

________________________

b. What is the concentration of fluoride ion in the final product in mg/ml?

________________________

c. Fill in the blanks in the following alligation table.

________________________

________________________

d. What volume of 1.1 mg/ml sodium fluoride solution is needed?

________________________

e. What volume of 4.4 mg/ml sodium fluoride solution is needed?

________________________
This is an effervescent antacid tablet. The sodium bicarbonate and the potassium bicarbonate neutralize stomach acid. Sodium bicarbonate (\(Na^+HCO_3^-\)) has molecular weight 84, potassium bicarbonate (\(K^+HCO_3^-\)) has molecular weight 100, and citric acid has molecular weight 210.

a. What is the concentration of sodium ion in pure sodium bicarbonate in grams/gram?

b. What is the concentration of sodium ion in the tablet?

c. Antacids must be labeled for sodium content if they contain more than 0.2 mEq of sodium per dose. What is the sodium content per dose in milliequivalents?

d. Assuming a glassful (8 ounces) is 240 ml, and that the effervescent reaction causes no change in volume, what is the concentration of sodium ion in the glass?

e. What alligation method would you use to calculate the concentration of bicarbonate in the tablet?

f. What is the concentration of bicarbonate ion in the tablet in grams/gram?
Problem 28

Dr. Lavash Foccacia, M.D.

<table>
<thead>
<tr>
<th>Name</th>
<th>French Baguette</th>
<th>Age</th>
<th>52 yr</th>
<th>Height</th>
<th>6ft 2 in</th>
</tr>
</thead>
<tbody>
<tr>
<td>Address</td>
<td>8 Baker Ct, Croissant, NY</td>
<td>Date</td>
<td>8/18/02</td>
<td>Weight</td>
<td>100 kg</td>
</tr>
</tbody>
</table>

**Rx**  
Potassium chloride  qs
Potassium acetate  qs
M ft 100 ml aqueous solution with 6.7 mEq K+ per 5 ml
1 tablespoon bid

You find that you do not have this solution available. After consultation, decide to prepare it by mixing a concentrated 0.4 mEq/ml potassium chloride solution with a 2 mEq/ml potassium acetate solution.

a. What is the potassium ion concentration in the dispensed preparation in milliequivalents/ml?

_________________________

b. What is the potassium ion concentration in the dispensed preparation in milligrams/ml?

_________________________

c. Fill in the blanks in the following alligation table.

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

_________________________

_________________________

d. How many milliliters of the potassium chloride solution are needed?

_________________________

e. How many milliliters of the potassium acetate solution are needed?

_________________________
Problem 31

<table>
<thead>
<tr>
<th>Name</th>
<th>Age</th>
<th>Wt</th>
<th>Address</th>
<th>Date</th>
<th>Height</th>
</tr>
</thead>
<tbody>
<tr>
<td>Piper Shepherd</td>
<td>52 yr</td>
<td>100 kg</td>
<td>8 Baker Ct</td>
<td>8/18/02</td>
<td>6 ft 2 in</td>
</tr>
</tbody>
</table>

Dr. Hunter Gatherer, M.D.

Phone 716-555-1234  
DEA# AT-12736280

**Potassium chloride solution**  
**qs**  
M ft 200 mL aqueous solution with 6.5 mEq K⁺ per 5 mL  
1 tablespoon bid

H. Gatherer, M.D.

---

a. What is the potassium ion concentration in the dispensed **preparation** in milliequivalents per mL?

---

b. You find that you do not have the desired solution available. After investigation, you decide to prepare it by mixing a 0.4 mEq/mL potassium chloride solution with a 2.0 mEq/mL potassium acetate solution. You use alligation alternate to determine the quantities of potassium chloride solution and potassium acetate solution. Fill out the five boxes in the following alligation table.

<table>
<thead>
<tr>
<th>Pot. Chloride solution</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pot. Acetate solution</td>
</tr>
</tbody>
</table>

---

c. How many milliliters of the potassium acetate solution are needed?

---

d. How many milliliters of the potassium chloride solution are needed?

---

e. What percentage of the total potassium in the preparation is provided by the potassium chloride solution?

---
Problem 36

<table>
<thead>
<tr>
<th>Name</th>
<th>Pam E. Diaz</th>
<th>Age</th>
<th>7yr</th>
<th>Height</th>
<th>60 cm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Address</td>
<td>8 Buckingham Pl, London</td>
<td>Date</td>
<td>8/18/02</td>
<td>Weight</td>
<td>20 kg</td>
</tr>
</tbody>
</table>

Rx  Cefaclor suspension 62.5 mg/5 ml  
Take 5 ml po tid

The manufacturers instructions for cefaclor suspension are: *Package contains 1.875 grams of cefaclor as dry powder. To reconstitute, add 45 ml of sterile water to bottle to obtain suspension containing 125 mg of cefaclor per 5 ml. Oversize bottle provides extra room for shaking.*

a. What instructions would you give the patient?

b. What is the volume of the suspension if it were to be reconstituted according to the manufacturer’s instructions?

c. What is the volume of the displaced by the powder if it were to be reconstituted according to the manufacturer’s instructions?

d. What is the volume of the suspension if it were to be reconstituted according to the instructions on the prescription?

e. What volume of sterile water would you add to obtain the concentration of cefaclor prescribed?

f. What volume of sterile water would you add to obtain a suspension containing cefalclor at a concentration of 150 mg/5 ml?
Ticarcillin disodium and clavulanate potassium is a combination antibiotic that contains the 30:1 ratio of ticarcillin to clavulanic acid. The dosage of the combination is expressed as the sum of the grams of ticarcillin plus grams of clavulanic acid. The manufacturer’s instructions for reconstitution of the parenteral concentrate are: “Each container is labeled as containing 3.1 grams of the combination and contains the potency equivalent to 3g of ticarcillin and 100 mg of clavulanic acid. Add 13 ml of sterile water to obtain a solution containing 200 mg/ml of ticarcillin. Shake vial until drug dissolves.”

a. What is the volume of the preparation if you diluted a 3.1 gram container of the combination according to the manufacturer’s instructions? What is the volume of displaced by the powder?

b. What is the quantity of the preparation when a 3.1 gram container of the combination is reconstituted as specified by the prescription.

c. How much sterile water must be added to a 3.1 gram container of the combination to obtain the concentration specified by the prescription.

d. How much of the reconstituted solution is required for a single dose of the drug? How much clavulanic acid is present in a single dose?
Problem 40

Dr. Tina DeMasajes
12 Jacuzzi St., Hot Springs, AK 30210

<table>
<thead>
<tr>
<th>Name</th>
<th>Address</th>
<th>Age</th>
<th>Height</th>
</tr>
</thead>
<tbody>
<tr>
<td>Calor Burbuja</td>
<td>144 Jacuzzi St, Hot Springs, AK</td>
<td>23 yr</td>
<td>5 ft 10 in</td>
</tr>
</tbody>
</table>

Date: 1/21/05
Weight: 80 kg

Cyclosporine 1:5000. Mft 30 ml ophthalmic suspension
1 gtt ou bid for keratoconjunctivitis

a. What is the concentration of cyclosporine in the ophthalmic suspension in % w/v?

b. Initially, you decide to prepare the suspension from an available 10% w/v cyclosporine solution in corn oil. How much of this solution do you need to prepare this suspension?

c. You find that you do not have a measuring device to measure the small volume in part (b) and therefore decide to use serial dilution to carry out three steps of dilution. In the first step (Step 1), you start from the 10% cyclosporine solution, and carry out a 1:20 dilution to obtain 50-mL of suspension. How many mL of 10% cyclosporine solution is needed for this Step?

d. What is the concentration (% w/v) of cyclosporine in the diluted solution obtained after Step 1?

e. In the second step (Step 2), you start from the cyclosporine suspension obtained after Step 1, and carry out a 1:10 dilution to obtain 50-mL of suspension. What is the concentration in the diluted suspension after Step 2?

f. In the last step (Step 3), you remove the exact volume of the suspension from Step 2 and dilute it to make the prescribed suspension. What volume of the suspension from Step 2 is needed?
Problem 41

Dr. Rosy Barb, M.D.
12 Bass St., Cape Cod, MA 30210

<table>
<thead>
<tr>
<th>Name</th>
<th>Age</th>
<th>Height</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pearl Danio</td>
<td>23 yr</td>
<td>5 ft 10 in</td>
</tr>
</tbody>
</table>

Phone 876-878-2421

DEA# BB -12736280

Potassium phosphate monobasic has the formula (KH$_2$PO$_4$) and potassium phosphate dibasic has the formula (K$_2$HPO$_4$).

a. What is the potassium ion concentration in the dispensed preparation in millimoles per mL?

b. Noting that each mole of potassium phosphate dibasic has two moles of potassium ion, what is the potassium ion concentration in the 3 mmoles/ml potassium phosphate dibasic solution in millimoles per mL?

c. You use alligation alternate to determine the quantities of 0.5 mmoles/ml potassium phosphate monobasic solution and 3 mmoles/ml potassium phosphate dibasic solution. Fill out the five boxes in the following alligation table.

\[
\begin{array}{c|c|c}
K^+ \text{ in } KH_2PO_4 \text{ solution} & & \\
K^+ \text{ in } K_2HPO_4 \text{ solution} & & \\
\end{array}
\]

d. How many milliliters of the 0.5 mmoles/ml potassium phosphate monobasic and 3 mmoles/ml potassium phosphate dibasic solution are needed?

e. What percentage of the total potassium in the preparation is provided by the potassium phosphate dibasic solution?
Outline

- Parenteral nutrition.
- Protein requirements: Urine urinary nitrogen and body weight-based methods
- Lipid, fluids, vitamins and minerals.

Parenteral Nutrition

- Provision of nutrients (protein, carbohydrate, fat, fluids, electrolytes, vitamins and minerals) via the intravenous route.
- Total parenteral nutrition (TPN) provides all nutrient requirements via the intravenous route. Generally requires a central vein due to high dextrose content.
- Peripheral (or partial) parenteral nutrition provides some nutritional requirements parenterally. Usually is a peripherally administered solution.
- Indicated when the GI tract is unusable or inaccessible. Patient in coma, having trouble swallowing or holding down food for extended periods of time due to vomiting or other gastrointestinal problems may be administered TPN.
- Administered centrally or peripherally dependent on dextrose.
- Central administration refers to directly accessing a vein connected to the superior vena cava. This is a high flow vein that allows administration of hypertonic solutions. Hypertonic solutions > 800 mOsm/L should be administered by a central vein.
- Maximum dextrose content administered peripherally is 10%. Amino acids and intravenous fat emulsions may be administered via a peripheral vein.

Calculation of Nutrient Requirements

- The primary nutrients provided by TPN via the intravenous route are protein, carbohydrate, fat, electrolytes, vitamins and minerals.
- Dextrose is the source of carbohydrates, amino acids are the source of protein and lipid emulsions are the source of fats and essential fatty acids. The excretion of the nitrogen in amino acids results in the production of urea in the urine and can be measured. Each of these nutrients sources provides energy, typically measured in Kilocalories.
- There are generally two methods each for obtaining nutrient requirements for energy and for protein. These can be based on body weight or on more detailed individualization (Harris-Benedict equation for calories and urine urea nitrogen for protein).

Energy Requirements

- There are two approaches, the Harris-Benedict equation and the alternative method based on body weight.
The **Harris-Benedict Equation** estimates the basal energy expenditure (BEE), amount of energy in kilocalories required to meet resting metabolic requirements. There is a separate equation for males and females. The equations are:

\[
BEE\ \text{Male} = 66 + 13.8 \times \text{Weight (kg)} + 5 \times \text{Height (cm)} - 6.8 \times \text{Age (years)}
\]

\[
BEE\ \text{Female} = 655 + 9.6 \times \text{Weight (kg)} + 1.8 \times \text{Height (cm)} - 4.7 \times \text{Age (years)}
\]

- Requires multiplication by a stress factor to estimate total Kcal requirements
  - Minimal stress: BEE × 1.2 - 1.4
  - Moderate stress: BEE × 1.4 - 1.6
  - Severe stress: BEE × 1.6 - 1.8

- For weight loss or gain the final Kcal amount is adjusted by 500 - 1000 Kcal/day.

**Calculation Example**: Use Harris-Benedict to determine Kcal requirements in the following patient: 34-year old female, 5 feet 5 inches, 134 lbs, moderate stress.

Height = 5' 5" = 65", 65 inches × 2.54 cm/inch = 165.1cm

Weight = 134 lbs × 1 kg/2.2 lb = 60.9 kg

\[
\text{BEE} = 655 + (9.6 \times 60.9) + (1.8 \times 165.1) - (4.7 \times 34) = 1386. \text{kcal}
\]

\[
\text{Kcal} = \text{BEE} \times \text{stress factor} = 1386 \times 1.4 \text{ to } 1386 \times 1.6 = 1940 - 2218 \text{ Kcal/day}
\]

- In the alternative method, the caloric requirement is based on the body weight and the stress level according to the following table:

<table>
<thead>
<tr>
<th>Stress Level</th>
<th>Kcal/kg/day</th>
</tr>
</thead>
<tbody>
<tr>
<td>Minimal</td>
<td>25 - 30</td>
</tr>
<tr>
<td>Moderate</td>
<td>30 - 35</td>
</tr>
<tr>
<td>Severe</td>
<td>35 - 40</td>
</tr>
<tr>
<td>Obese</td>
<td>20 - 25</td>
</tr>
<tr>
<td>Weight gain</td>
<td>40 - 50</td>
</tr>
</tbody>
</table>

**Calculation Example**: Use alternative method to determine Kcal requirements in the following patient: 34-year old female, 5 feet 5 inches, 134 lbs, moderate stress.

Weight = 134 lbs × 1 kg/2.2 lb = 60.9 kg

\[
\text{Kcal} = 30 \ \text{kcal/kg} \times 60.9 \ \text{kg} = 1827 - 2132 \ \text{Kcal/day}
\]

- Caloric value of proteins, carbohydrate and lipids are listed in below:

<table>
<thead>
<tr>
<th>Stress Level</th>
<th>Caloric value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Protein</td>
<td>4 Kcal/g</td>
</tr>
<tr>
<td>Dextrose</td>
<td>3.4 Kcal/g</td>
</tr>
<tr>
<td>Lipids 10% w/v emulsion</td>
<td>1.1 Kcal/ml</td>
</tr>
<tr>
<td>Lipids 20% w/v emulsion</td>
<td>2 Kcal/ml</td>
</tr>
<tr>
<td>Lipids 30% w/v emulsion</td>
<td>3 Kcal/ml</td>
</tr>
</tbody>
</table>
Calculation Example: Calculate the caloric content of a TPN solution containing 1000 ml of 10% amino acids, 500 ml of 70% dextrose and 250 ml of 20% w/v lipid emulsion.

- Kcal from amino acids = 1000 ml × 10 g/100 ml × 4 Kcal/g = 400 Kcal
- Kcal from dextrose = 500 ml × 70 g/100 ml × 3.4 Kcal/g = 1190 Kcal
- Kcal from fat = 250 ml × 20 g/100 ml × 2 Kcal/g = 500 Kcal

Total Kcal = 400 + 1190 + 500 = 2090 Kcal

Protein Requirements

- There are two approaches for arriving at protein requirements, the Dudrick method and the more individualized urinary urea nitrogen method.
- In the **Dudrick method**, the protein requirement is based on the body weight and the stress level according to the following table:

<table>
<thead>
<tr>
<th>Stress Level</th>
<th>Grams/kg/day</th>
</tr>
</thead>
<tbody>
<tr>
<td>US Recommended daily allowance</td>
<td>0.8</td>
</tr>
<tr>
<td>Minimal</td>
<td>1.0 – 1.2</td>
</tr>
<tr>
<td>Moderate</td>
<td>1.4 – 1.6</td>
</tr>
<tr>
<td>Severe</td>
<td>1.8 – 2.0</td>
</tr>
<tr>
<td>Burns</td>
<td>2.0 – 3.0</td>
</tr>
</tbody>
</table>

Calculation Example: Use Dudrick method to determine protein requirements in the following patient: 45-year old male, 6 feet 2 inches, 210 lbs with severe stress.

Weight = 210 lbs × 0.4536 kg/lb = 95.45 kg

Protein = 1.8 g/kg × 95.45 kg to 2 g/kg × 95.45 kg = 172 - 191 g/day

- In the **Urine Urea Nitrogen (UUN)** method, the protein requirement is highly individualized and is based on conducting nitrogen balance calculations.

- Protein catabolism results in the production of urea and the majority of urea is excreted in urine. A small amount of urea is lost in sweat, stool and respiratory mechanisms and is corrected for as ‘insensible loss’. The amount of urinary urea and insensible nitrogen loss is thus a measure of the protein catabolism. One gram of urea nitrogen corresponds to 6.25 grams of amino acids or protein.

- The desired nitrogen balance is typically +3 to +6 grams per day. This indicates that the daily nitrogen input via the amino acids in the nutritional formulation exceeds the total nitrogen lost from the body by 3-6 grams.

- In the first step, the amount of urea nitrogen excreted is calculated from the estimated quantity of daily urine output and the urine urea nitrogen (UUN) concentration measured in the urine. The daily urine output is obtained by measuring the volume of urine over a collection period, e.g., 12-hours. The UUN is obtained from laboratory analysis.

- Insensible losses of nitrogen are estimated – typically an insensible loss of 4 g/day is assumed – and added to amount of urine nitrogen excreted. This gives the total nitrogen output for the patient.
Calculation Example

Formulate a TPN for a 45 year-old, 95.45 kg patient with 40 Kcal/kg day. UUN of 890 mg/dl. Dextrose and lipid to each provide 50% of non-protein Kcal. Protein based on +3 nitrogen balance. Fluid 35 ml/kg day. Patient has 12-hour urine volume of 875 ml. Assume insensible losses of 4 g/day. Electrolytes/1000 Kcal: Sodium 40 mEq; Potassium 30 mEq; Magnesium 8 mEq; Calcium 2 mEq; Phosphate 12 mmoles. Add 10 ml MVI-12 and 1 ml MTE-5.

• Protein Requirements:
  Amount of urea nitrogen out in urine = 1.75 liters × 8.90 g/L = 15.575 g
  Total urea nitrogen out = Loss in urine + Insensible loss = 15.575 + 4 = 19.575 g
  Nitrogen in = Nitrogen out + Nitrogen balance = 19.575 + 3 = 22.575 g nitrogen
  Amino acids or protein needed = 22.575 g × 6.25 g protein/g nitrogen = 141 g
  Volume of 10% amino acid stock solution = 1410 ml

• Caloric Requirements:
  Using alternate method, Total Kcal = 40 kcal/kg × 95.45 kg = 3818 Kcal
  Protein Kcal = 141 g protein × 4 Kcal/g = 564 Kcal
  Non-Protein Kcal = 3818 – 564 = 3254 Kcal
  Lipid Kcal = 0.5 × 3254 = 1627 Kcal
  Dextrose Kcal = 0.5 × 3254 = 1627 Kcal

• Lipid Requirements:
  Lipid emulsion 20% w/v volume = 1627 Kcal/(2 Kcal/ml) = 813.5 ml

• Dextrose Requirements:
  Grams of dextrose = 1627 Kcal/(3.4 Kcal/g) = 478.5 g
  Volume of 70% w/v dextrose solution = 478.5 g/(0.7 g/ml) = 684 ml

• Electrolyte Requirements:
  Sodium required = 3818 kcal × 40 mEq/1000 Kcal = 153 mEq
  Volume of 4 mEq/ml NaCl stock = 153 mEq/4 mEq/ml= 38.2 ml
  Magnesium required = 3818 Kcal × 8 mEq/1000 Kcal = 30.5 mEq
  Volume of 4.05 mEq/ml stock solution = 30.5 mEq/4.05 mEq/ml = 7.5 ml
  Calcium required = 3818 Kcal × 2 mEq/1000 Kcal = 7.6 mEq
  Volume of 0.46 mEq/ml calcium gluconate = 7.6 mEq/(0.46 mEq/ml) = 16.6 ml
  Phosphate required = 3818 Kcal × 12 mMol/1000 Kcal = 46 mmoles
  Volume of 3 mmol/ml potassium phosphate = 46 mmol/3 mmol/ml = 15.33 ml
  3 mmol/ml potassium phosphate contains mEq/ml of potassium ion.
Potassium from potassium phosphate = 15.33 ml × 4 mEq/ml = 61.3 mEq
Total potassium required = 3818 Kcal × 30 mEq/1000 kcal = 115 mEq
Potassium remaining = 115 – 61.33 = 53.67 mEq
Volume of 2 mEq/ml potassium acetate = 26.8 ml
Total volume of Electrolytes = 26.8 + 15.33 + 16.6 + 7.5 + 38.2 = 104.4 ml
Volume of MVI-12 and MTE-5 = 11 ml

- **Fluid Requirements:**

  Total fluids = 95.45 × 35 ml/kg = 3340.75 ml
  Fluids from macronutrients = 1410 + 813.5 + 684 = 2907.5 ml
  Fluids from micronutrients = 104.4 + 11 = 115.4 ml
  Water needed for qsad = 3340.75 – 2907.5 = 433.25 = 433 ml
  Infusion flow rate = 3340.75 ml/24 hours = 139.2 ml/hour
**Problem 2**

<table>
<thead>
<tr>
<th>Name</th>
<th>Bianca Baptista</th>
<th>Age</th>
<th>Wt</th>
<th>80 kg</th>
</tr>
</thead>
<tbody>
<tr>
<td>Address</td>
<td>144 Hortensio St, Padua, DE 19805</td>
<td>Date</td>
<td>1/10/95</td>
<td>Height</td>
</tr>
</tbody>
</table>

Make 1 days requirement of TPN solution. Infuse over 24 hours.

**Calories:** 35 Kcal/kg. 30% of non-protein Kcal to come from 20% w/v lipid emulsion. Remainder 70% of non-protein Kcal from 70% w/v dextrose solution.

**Protein:** 1.8 g/kg/day as 10% w/v amino acid solution

**Fluid:** 40 ml/kg

**Electrolytes, multivitamins, trace elements**

---

a. How many kilocalories per day should be provided?

---

b. How many kilocalories come from dextrose?

---

c. What volume of 70% w/v dextrose is needed?

---

d. What volume of 20% w/v lipid emulsion is needed?

---

e. What is the infusion flow rate in ml/minute?
Problem 6

Dr. Gertrude Claudius, M.D.
72 Guildenstern Court, Elsinore, CA 92532

<table>
<thead>
<tr>
<th>Name</th>
<th>Ophelia Hamlet</th>
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<tbody>
<tr>
<td>Address</td>
<td>5184 Rosencrantz, St. Elsinore, CA 45900</td>
</tr>
<tr>
<td>Age</td>
<td>25 yr</td>
</tr>
<tr>
<td>Sex</td>
<td>Female</td>
</tr>
<tr>
<td>Date</td>
<td>10/8/05</td>
</tr>
<tr>
<td>Height</td>
<td>5ft 6 in</td>
</tr>
<tr>
<td>Weight</td>
<td>165 lb</td>
</tr>
</tbody>
</table>

**Rx**
M. TPN. Severe burns, stress factor: 1.8
Protein 3 g/kg/day, and 250 ml lipids from intralipids 20% sol.

The patient had the following urinary urea nitrogen analysis: Total urine volume = 850 ml, collection time = 12 hours, urea nitrogen = 1800 mg/dl. Assume insensible losses of 4 g/day).

a. Calculate the total caloric requirement.

b. Calculate the calories contributed by protein.

c. Calculate the calories contributed by lipids.

d. How many ml of 40% dextrose solution are needed to compound the TPN formula?

e. Calculate the patient’s nitrogen balance. You must indicate the mathematical sign.

f. How many grams of protein per day will be required to provide a nitrogen balance of +4?
Problem 7

Phone 305-425-6969  DEA# BC-12736280

Crista Iliaca, MD
121 Cremaster Avenue, Palmaris, MI 20210

<table>
<thead>
<tr>
<th>Name</th>
<th>Latissmus Dorsi</th>
<th>Age</th>
<th>56</th>
<th>Weight</th>
<th>76 kg</th>
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</thead>
<tbody>
<tr>
<td>Address</td>
<td>11 Sartorius Street, Palmaris</td>
<td>Sex</td>
<td>Male</td>
<td>Height</td>
<td>180 cm</td>
</tr>
<tr>
<td>Date</td>
<td>2/25/05</td>
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<td></td>
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</table>

Dx: Crohn's disease. Infuse TPN containing 120 g amino acids; 425 g dextrose and 65 g lipids intravenously at 100 ml/hour via central line.

a. What total volume of 20% w/v lipid emulsion is required for this TPN?

b. How many total kilocalories is this patient receiving?

c. How many grams of nitrogen is the patient receiving?

d. The total urine volume for the patient for a 12-hour collection period was 875 ml and the urinary urea nitrogen was 1090 mg/dl. Calculate the patient’s nitrogen balance assuming 4 g/day of insensible losses.

e. The physician wants to change the prescription to provide enough protein to achieve a +4 nitrogen balance. How many grams of protein per day will now be required? How many milliliter of 8.5% stock solution of amino acids would be required to compound this new prescription?
Problem 8

Dr. Tara Antula, M.D.
12 Coneweb St., Huntsman, VA 47149

Date: January 21, 2005

Make 1 days requirement of TPN solution. Infuse over 24 hours.

Calories: Patient has burns: use stress factor 1.75. 30% of non-protein Kcal to come from fat. Remainder 70% from dextrose.

Protein: Urine volume over 12 hrs is 800 ml and UUN is 1000 mg/dl. Provide +6 nitrogen balance. Insensible loss: 4 g/day.

Fluid: 40 ml/kg
Electrolytes, multivitamins, trace elements

a. How many kilocalories per day should be provided?

b. According to the urinary urea nitrogen figures alone, how many grams of protein is the patient using per day?

c. How much protein per day is required to provide nitrogen balance (a balance of zero)?

d. How much protein per day is required to provide the nitrogen balance prescribed? How many kilocalories are obtained from protein in the prescribed regimen? You have a 10% w/v amino acid solution available. What volume of this solution is needed?

e. The patient was previously receiving 150 grams of amino acid. What was the nitrogen balance for this regimen.
Problem 21

UNIVERSITY HOSPITAL
School of Pharmacy, 221 Cooke Hall, Buffalo, New York, 14260

Patient: June Fields
DOB: 3/22/1944
Room: 844-A
Height (circle one): 5' 4"
Sex: female
Weight (circle one): 135

DATE/TIME
11/6/2006

RECORD ON ADMISSION ONLY, DOCUMENT TYPE OF ALLERGIC REACTION
Allergies: NKA
Adverse Reactions:

PARENTERAL NUTRITION ORDER FORM
Order must be received in Pharmacy by 12:00 noon in order to initiate or continue treatment. Nutrition solution must be reordered daily.

CONSULT NUTRITION SUPPORT FOR ASSISTANCE IN PRESCRIBING

INFUSION SITE: ☑ CENTRAL ☐ PERIPHERAL
INFUSION RATE: 60 ml/hr x 24 hours

STANDARD FORMULAS

☐ FAAD (Fat Containing Central – 5% Amino Acids, 17.5% Dextrose & 2.5% Fat Emulsion)
☐ SCAAS (Standard Central – 6% Amino Acids & 25% Dextrose)
☐ SPAAS (Standard Peripheral – 5% Amino Acids & 5% Dextrose)
☐ HIGH HCO (High Carbohydrate Central – 5% Amino Acids & 35% Dextrose)
☑ OTHER (specify) FAD pharmacy to dose, patient post operative

☐ FAT EMULSION 10% 500 ml daily at 20 ml/hr

ELECTROLYTE

<table>
<thead>
<tr>
<th>Electrolyte</th>
<th>Contained in each Standard Formula/mL</th>
<th>Additional/L</th>
<th>Depletion/L</th>
</tr>
</thead>
<tbody>
<tr>
<td>Na</td>
<td>55 mEq</td>
<td>45 mEq</td>
<td></td>
</tr>
<tr>
<td>K</td>
<td>20 mEq</td>
<td>30 mEq</td>
<td></td>
</tr>
<tr>
<td>Ca</td>
<td>15 mEq</td>
<td>45 mEq</td>
<td>5 mEq</td>
</tr>
<tr>
<td>Mg</td>
<td>5 mEq</td>
<td>50 mEq</td>
<td>5 mEq</td>
</tr>
<tr>
<td>Cl</td>
<td>55 mEq</td>
<td>5 mEq</td>
<td>15 mEq</td>
</tr>
<tr>
<td>Phos</td>
<td>15 mM</td>
<td>50 mEq</td>
<td>55 mEq</td>
</tr>
<tr>
<td>Acetate</td>
<td>73 mEq</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

☑ Insulin, Regular Human 25 units/Liter
☐ Other

Multi-vitamins and Trace Elements standard amount to daily diet

Nutrition Profile (Mondays & Thursdays): P7, Pre Albumin, Transferrin, Mg Level, Lipid Profile

* Please provide 50 ml overfill for line prime

PHYSICIAN SIGNATURE: [Signature]
(Resident: Print last name)

Page 10.33
i. How many grams of carbohydrate will be needed to compound this TPN order?

j. How many kilocalories will be provided by the carbohydrate source?

k. What volume of the 70% w/v dextrose source solution will be needed to compound this TPN order?

l. What will be the total volume of this parenteral preparation?

m. How many mEq of Sodium must be present in this preparation?

n. How many mEq of Potassium must be present in this preparation?

o. How many mEq of Chloride must be present in this preparation?

p. How many mEq of Acetate must be present in this preparation?

q. What volume of the 4 mEq/ml sodium chloride source will be required to compound this TPN order?
Outline
- Where does osmotic pressure come from?
- Why is osmotic pressure important?
- Introduce some important terms and units of osmotic pressure
- Calculations for isotonic preparations:
  - Osmolarity method
  - Freezing point depression
  - Sodium chloride equivalents

Where Does Osmotic Pressure Come From?
- Many pharmaceutical preparations have to be made isotonic to ensure proper product performance. The concept of isotonicity is directly related to osmotic pressure, which we will discuss.

Figure 10.1. Schematic for osmotic pressure
- When a dilute solution and a concentrated solution are separated by a semi-permeable membrane, solvent will flow so that the two concentrations will be equalized. This process is called osmosis.
- The solute cannot pass through the membrane; therefore, the concentrated solution is diluted as the solvent flows. The force driving this movement of solvent is osmotic pressure. This is shown in Figure 10.1.
- The solvent flows from the region of high SOLVENT concentrations to the region of low SOLVENT concentration.
Why Is Osmotic Pressure Important?

- Recall from biochemistry that every cell is surrounded by a cell phospholipid bilayer membrane and that bilayers are virtually impermeable to ions. The exclusion of ions makes cell membrane semi-permeable.

- When we administer pharmaceutical solutions, they may be:
  - concentrated solutions (e.g. drugs or salts)
  - dilute solutions (e.g. fluids to replace loss of circulatory volume)

- Examples of body fluids into which pharmaceutical solutions are administered include tears, nasal fluid, blood, intestinal contents.

- If the osmotic pressure of the solutions we administer does not equal the osmotic pressure of the body fluid into which the drug is administered, water may enter or leave the cell causing undesirable effects such as:
  - Pain/discomfort, e.g., stinging eyedrops
  - Tissue damage, e.g., hemolysis or destruction of red cells in blood.

Some Important Terms

- If two solutions have the same osmotic pressure, they are: **Isoosmotic**.
- If a solution has the same osmotic pressure as a specific body fluid, it is: **Isotonic**
- “Isotonic” is a relative term that refers to the biological effects of osmotic pressure. Different body fluids may have different compositions and therefore differing osmotic pressure. Therefore, the osmotic pressure of an “isotonic” solution meant for one body fluid may not be the same as the osmotic pressure of an “isotonic” solution meant for a different body fluid. A solution that is isotonic with human blood may not be isotonic with blood from another species such as whale, a fish or frog.
Problem 2

a. You are taking care of Shamu, a baby whale at the local marine mammal center. The body fluids of a whale are isotonic with seawater, which is approximately 3% sodium chloride. Calculate the osmolarity of seawater in mOsmoles/Liter.

b. A patient enters the emergency room with edema (swelling due accumulation of fluid) of the eye. The physician orders the application of a few drops of pure glycerin. Given what you know of isotonicity, does this make sense? Will the edema increase, stay the same or decrease?

c. An eye drop solution freezes at -0.4°C. What is the freezing point depression of the solution? Is the eye drop solution hypo- hyper- or isotonic with respect to lachrymal fluid?

d. You have an eye drop solution with a freezing point depression of 0.74°C. If you mix 1 volume of this eyedrop solution with 1 volume of water, what will the freezing point depression of the diluted solution be? Will the resulting solution be hypotonic, isotonic, or hypertonic with respect to lachrymal fluid?

e. A solution has a freezing point of -0.87°C. Is this solution hypertonic, isotonic or hypotonic? Two ml of the solution is mixed with 1 ml of water. Is the resulting solution isotonic, hypertonic or hypotonic?
Problem 4

Magma Felsic, MD
Crater Rock, HI 14002

<table>
<thead>
<tr>
<th>Name</th>
<th>Address</th>
<th>Age</th>
<th>Date</th>
<th>Weight</th>
<th>Height</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ash Andesitic</td>
<td>11 Dome Street, CR</td>
<td>30</td>
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<td>80 kg</td>
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</tr>
</tbody>
</table>

Irrigate with 1L of 0.45% sodium chloride solution

M. Felsic M.D

a. What abbreviation frequently used denote 0.45% sodium chloride?

b. Is this solution isotonic, hypotonic or hypertonic?

c. Would red cells lyse, shrink or stay unaffected in this solution?

d. Calculate the osmolarity of this solution.

e. Calculate the freezing point depression of this solution.
Problem 5

**Dr. Ashbury Haight**
13 Oak Street
San Francisco, CA 94143

<table>
<thead>
<tr>
<th>Name</th>
<th>Richmond Castro</th>
<th>Age</th>
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<th>Weight</th>
<th>Height</th>
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<tbody>
<tr>
<td>Address</td>
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<td>15</td>
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</table>

Rx

- Boric acid
- Sterile water qsad
- m ft SA isotonic solution
- Sig: ii gt ou q4h

---

a. What is the freezing point depression of a 1% boric acid solution?

b. What is the sodium chloride equivalent of boric acid?

c. Calculate the concentration of boric acid required for an isotonic solution using the freezing point method.

d. Calculate the amount of boric acid required using the freezing point method.

e. Calculate the amount of boric acid required for an isotonic solution using the sodium chloride equivalent method.
**Problem 8**

<table>
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<tr>
<th>Name</th>
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<th>Address</th>
<th>Date</th>
<th>Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bramble Sawshark</td>
<td>52 yr</td>
<td>6ft 2 in</td>
<td>8 Thresher Pl, Hammerhead, CT</td>
<td>8/12/05</td>
<td>100 kg</td>
</tr>
</tbody>
</table>

**Dr. Angel Bullhead, M.D.**

| Rx            | Sterile water qs ad | 100 ml | M ft SA isotonic solution; 2 gtt ou q3h |

---

a. What is the freezing point depression of a 1% solution of sulfacetamide sodium?

b. What is the concentration of sulfacetamide sodium in the isotonic preparation? Use the freezing point depression method. Sulfacetamide sodium is a solid.

c. What concentration of sodium chloride would have the same osmotic pressure as a 1% w/v solution of sulfacetamide sodium?

d. What is the concentration of sulfacetamide sodium in the isotonic preparation? Use the sodium chloride equivalent method.

e. What is the concentration of sulfacetamide sodium in the isotonic preparation? Use the osmolality or \( i \)-factor method. Assume sulfacetamide sodium is a 2-ion electrolyte. Express your answer in percent strength.
Problem 9

Phone 305-425-6969 DEA# BC -12736280

Coquina Dolomite, MD
121 Anthracite Avenue, Flint, MI 20210

<table>
<thead>
<tr>
<th>Name</th>
<th>Breccia Obsidian</th>
<th>Age</th>
<th>19</th>
<th>Weight</th>
<th>88 kg</th>
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<tbody>
<tr>
<td>Address</td>
<td>11 Shale Street, Flint</td>
<td>Date</td>
<td>2/25/05</td>
<td>Height</td>
<td>190 cm</td>
</tr>
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</table>

Infuse 1L of D5W IV over 2 hours.

Assume that the dextrose concentration in D5W refers to anhydrous dextrose and not dextrose monohydrate (dextrose•H₂O). Anhydrous dextrose is a non-electrolyte that has a molecular weight of 180 g/mole.

a. Calculate the molarity of anhydrous dextrose in D5W

b. Calculate the osmolarity of D5W.

c. Express the concentration of dextrose in D5W in terms of percent w/v of dextrose monohydrate.

d. What is the freezing point depression of the solution?

e. What is the sodium chloride equivalent of the solution as % w/v?
Problem 11

Kelly Walsh, MD
15 Melrose Ave, Beverly Hills, CA 90210

<table>
<thead>
<tr>
<th>Name</th>
<th>Donna Scanlon</th>
<th>Age</th>
<th>Weight</th>
<th>Date</th>
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<tbody>
<tr>
<td>Address</td>
<td>225 Wilshire Blvd, Beverly Hills</td>
<td>5</td>
<td>20 kg</td>
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R

- Atropine sulfate 0.5%
- Boric acid qs
- Sterile water qsad 50 ml
- m ft SA isotonic solution
- Sig: ii gt ou q4h

a. What is the freezing point depression of a 1% atropine sulfate solution? What is the contribution of the atropine sulfate to the freezing point depression of the solution?

b. Calculate the freezing point contribution required from boric acid to make the solution isotonic.

c. Calculate the concentration of boric acid required using the freezing point method.

d. Calculate the sodium chloride equivalents contributed by the atropine sulfate.

e. Calculate the sodium chloride equivalents contribution required from the boric acid.

f. Calculate the amount of boric acid required using the SCE method.
Problem 12

<table>
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<td>Dana Mulder</td>
<td>15</td>
<td>50 kg</td>
<td>Calusari Street, Quantico</td>
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<tbody>
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<td>10/01/97</td>
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Neomycin sulfate 0.5%
Polymixin B sulfate 10,000 units/ml
Boric acid qs
Sterile water qsad 75 ml
m ft SA isotonic solution
Sig: ii gt os bid

Polymyxin B sulfate has a specific activity of 6000 units/mg. The freezing point depression of a 1% solution is 0.04°C and the sodium chloride equivalents is 0.1.

a. Calculate the concentration of polymyxin B sulfate in % strength. Determine the amount of polymyxin B sulfate needed.

________________________

b. Calculate the boric acid required using the SCE method.

________________________

c. Calculate the boric acid required using the freezing point method.

________________________
**Problem 16**

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<tr>
<th>Name</th>
<th>Ruby Spinel</th>
<th>Age</th>
<th>62</th>
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<th>75 kg</th>
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<tbody>
<tr>
<td>Address</td>
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<td>Date</td>
<td>1/15/05</td>
<td>Height</td>
<td>150 cm</td>
</tr>
<tr>
<td>R</td>
<td>Atropine sulfate 1%</td>
<td>Boric acid QS</td>
<td>Purified water qsad 50 ml</td>
<td>Sterile water QS</td>
<td>m ft sterile isotonic sol. No preservative.</td>
</tr>
<tr>
<td></td>
<td>Sig: i gtt od before Next appointment</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

a. What is the freezing point depression of atropine sulfate in the solution?  
__________________________

b. What is the freezing point depression contribution needed from boric acid?  
__________________________

c. What is the concentration of boric acid based on the freezing point depression method?  
__________________________

d. What is the sodium chloride equivalent contribution (in % w/v NaCl) needed from boric acid?  
__________________________

e. Calculate the boric acid concentration using the sodium chloride equivalent method?  
__________________________
Silver nitrate solution is widely administered to newborns to prevent eye infections. Sodium acetate has a molecular weight of 82, a $\Delta T_f^{1\%}$ of 0.25°C and a sodium chloride equivalent of 0.45.

a. Calculate the amount of silver nitrate required to compound this prescription.

b. Determine the freezing point depression of the silver nitrate solution prior to the addition of sodium acetate.

c. Calculate the concentration of sodium acetate in the isotonic solution using the freezing point depression method.

d. Calculate the amount of sodium acetate required to compound this prescription?
**Problem 21**

<table>
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<th>Name</th>
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<th>Weight</th>
<th>Height</th>
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<tr>
<td>Maitaki Shiitake</td>
<td>13 Portobello Rd. SG</td>
<td>9</td>
<td>9/28/97</td>
<td>30 kg</td>
<td>4 ft</td>
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**Phenylephrine hydrochloride**
- 0.12%

**Zinc sulfate.7H2O**
- 0.25%

**Water qs ad**
- 100 ml

m ft isotonic solution

Sig: ii gtt od qid

---

a. What is the **freezing point** of a 1% solution of phenylephrine hydrochloride?

---

b. What is the contribution of phenylephrine hydrochloride to the **freezing point depression** of the preparation?

---

c. What is the **freezing point** of 1% solution of zinc sulfate.7H2O?

---

d. What is the contribution of zinc sulfate.7H2O to the **freezing point depression** of the preparation?

---

e. What is the **freezing point depression** of the preparation? Is the solution isotonic, hypertonic or hypotonic?

---
Problem 23

Dr. Hal O’Ween, M.D.  
3 Treat Street  
Eerie, PA  

<table>
<thead>
<tr>
<th>Name</th>
<th>Jack O’Lantern</th>
<th>Age</th>
<th>Height</th>
<th>Address</th>
<th>Date</th>
<th>Weight</th>
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<tr>
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<td>170 cm</td>
<td>10/31/07</td>
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R  Sulfacetamide sodium 15% w/v  
m fsa sterile ophthalmic sol  
1 gtt ou q4h

H. O’Ween, MD

a. What is the site of administration?

b. What is the freezing point of a 1% sulfacetamide solution?

c. What is the freezing point of the sulfacetamide solution in the preparation?

d. Is the solution isotonic, hypotonic or hypertonic?  Why?

e. How much is sulfacetamide is present in a single dose.
Problem 30

<table>
<thead>
<tr>
<th>Name</th>
<th>Ken Tucky</th>
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<th>Weight</th>
<th>Address</th>
<th>Date</th>
<th>Height</th>
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<tbody>
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</table>

R

Sulfacetamide sodium
Sterile water qs ad
m ft SA isotonic
i gtt ou q2h conjunctivitis

Tim Buktu, MD

a. What is the freezing point depression of a 1% solution of sulfacetamide sodium?

b. Using the freezing point depression method, determine the concentration of sulfacetamide sodium in the isotonic solution.

c. What is the freezing point of a 2% solution of sulfacetamide sodium in water?

d. Calculate the concentration of sulfacetamide sodium in the isotonic preparation using the sodium chloride equivalents method.

e. Calculate the amount of sulfacetamide sodium in the isotonic preparation using the sodium chloride equivalents method.
# Problem 36

<table>
<thead>
<tr>
<th>Name</th>
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<tbody>
<tr>
<td>Jack Beanstalk</td>
<td>13 yr</td>
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<table>
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<th>Address</th>
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<tr>
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<td>8/18/02</td>
<td>40 kg</td>
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<table>
<thead>
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<th>Rx</th>
<th>Description</th>
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<tbody>
<tr>
<td>Sodium bicarbonate qs</td>
<td>Sterile water for injection qs ad 500 ml M ft sa isotonic sol. Infuse 2 mEq/kg iv over 4 hours</td>
</tr>
</tbody>
</table>

R. Bleubeard, MD

Sodium bicarbonate ($Na^+(HCO_3^-)$) is used to correct metabolic acidosis.

a. Calculate the dose of sodium bicarbonate in milliequivalents and the dose in grams.

b. What is the sodium chloride equivalent of sodium bicarbonate?

c. Calculate the concentration of sodium bicarbonate in the infusion fluid. Use the sodium chloride equivalent method.

d. What is the freezing point depression of a 1% w/v sodium bicarbonate solution?

e. Calculate the concentration of sodium bicarbonate in the infusion fluid. Use the freezing point depression method.
Problem 41

Dr. Tom Ahawk, M.D.

Name: Apache Falcon  Age: 18 yr  Height: 5’4”
Address: 8 Sidewinder Street, Hornet, TN  Date: 8/18/02  Weight: 125 lb

RX
- Sodium acid phosphate monohydrate (NaH₂PO₄ H₂O) 0.46 % w/v
- Sodium phosphate anhydrous 0.46% w/v
- Sodium chloride qs
- Sterile water qsad 100 ml
- M ft SA isotonic solution

T. Ahawk, MD

a. Calculate the concentration of sodium chloride that would exert the same osmotic pressure as the sodium acid phosphate monohydrate concentration in the preparation? Calculate the concentration of sodium chloride that would exert the same osmotic pressure as the sodium phosphate anhydrous concentration in the preparation?

b. What is the concentration of the sodium chloride added to make the solution isotonic?

c. A pharmacy technician weighs each of the three ingredients correctly but inadvertently makes the final volume up to 50 ml with sterile water (instead of the 100 ml prescribed). Calculate the freezing point depression of the resultant solution?

d. The pharmacy technician who made the error in part (d) above was fired and the pharmacist began testing a candidate who applied for the position. This candidate was given the same task. However, this candidate did all the calculations correctly. However, the candidate forgot to add the sodium chloride. All other steps were correctly done. Calculate the freezing point depression of the resulting preparation.
Problem 46

Phone 609-393-8086
Dr. Barbera Bordeaux
11 Zinfandel St, Pinotage
DEA# BB12736280

<table>
<thead>
<tr>
<th>Name</th>
<th>Shiraz Chianti</th>
<th>Age</th>
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<th>Height</th>
<th>6 ft 2 in</th>
<th>Weight</th>
<th>90 kg</th>
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<td>Date</td>
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Rx

15% w/v sulfacetamide sodium qs
Purified water qs ad 50 mL
Make isotonic solution
Sig: 2 gtt ou q6h for glaucoma

a. Calculate the concentration of sulfacetamide sodium in the isotonic solution of sulfacetamide sodium. Use the freezing point depression. Express your answer in % w/v.

__________________________

b. Sulfacetamide sodium is a 2-ion electrolyte. Calculate the concentration of sulfacetamide sodium in the isotonic solution of sulfacetamide sodium using the osmolarity method. Express your concentration in millimoles/ml.

__________________________

c. Express the concentration of sulfacetamide sodium in the isotonic solution in % w/v.

__________________________

d. Using the sodium chloride equivalent method, calculate the concentration of sulfacetamide sodium in the isotonic solution of sulfacetamide sodium.

__________________________

e. How many mL of the 15% solution of sulfacetamide sodium should be used for compounding this preparation? Use your answer from part (e) above.

__________________________
### Important Mathematical Functions in Pharmacy

- **The exponential function** is widely used in pharmacokinetics, in characterizing bacterial growth and in describing drug stability.
- **The logarithmic function** is the inverse of the exponential function. It is used in physical pharmacy because $\text{pH}$ and $\text{pK}_a$ are logarithmic in nature. Some pharmacological dose-response curves are also logarithmic in nature.
- **The hyperbolic function** is widely used to describe the relationships between drug concentration and drug receptor occupancy. The familiar Michaelis-Menten equation used for describing enzyme kinetics and dose-responses is hyperbolic in nature. The hyperbolic function will not be covered in this workbook.

### General Approaches To Understanding Functions

- Plot the function on graph paper and watch how it changes when the value of $x$ is changed.
- Determine its value at $x = 0$.
- Determine its value at $x = \infty$. Even though the value $x = \infty$ is physically unattainable, such an analysis often provides insight into how the function will behave at large values of $x$.
- Determine its rate of change at $x = 0$. Is the plot initially steep? When does it "slow" down?
- Determine its rate of change at $x = \infty$. Does the plot reach an asymptote?
- Determine the maximum and minimum values of the function.
- What operations are legal? Which operations are illegal? Which operations seem legal but really are not?
- Why is this function useful? What characteristics make it useful for describing the physical processes for which it is used?

### The Exponential Function

- In general terms, the exponential function can be expressed in the form $y = a^x$. The number $a$ is called the **base** and the number $x$ is called the **exponent** or **index**.
- The natural base $e$ and 10 are the most frequently encountered bases. The base 2 is frequently is used in the area of computers and information processing.
- The natural base $e$ has a numerical value of 2.718.
- Some general rules:
The Exponential to Base \( e \)

- The exponential function to the natural base \( e \) is a special case of the general exponential form \( y = a^x \). For convenience we will write it in the form \( C = C_0 e^{kt} \), where \( C \) is the concentration, \( C_0 \) is the concentration at time \( t = 0 \). This form of function is frequently used for expressing time-dependence of drug concentrations.

The Pharmacy Calculations Workbook

<table>
<thead>
<tr>
<th>( a^1 = a )</th>
<th>( a^2 = a \times a )</th>
<th>( a^n = a \times a \times \ldots \ n \text{ times} )</th>
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<tbody>
<tr>
<td>( (1/a) = a^{-1} )</td>
<td>( a^{1/2} = \sqrt{a} )</td>
<td>( a^0 = 1 )</td>
</tr>
<tr>
<td>( a^n \times a^m = a^{n+m} )</td>
<td>( (a^n)/(a^m) = a^{n-m} )</td>
<td>( (ab)^m = (a^m b^m) )</td>
</tr>
<tr>
<td>( (a/b)^m = (a^m/b^m) )</td>
<td>( (a^n)^m = a^{nm} )</td>
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</table>

Figure 13.1. Graphs of exponential decay (on left) and exponential growth (on right) illustrating the time dependence of the processes on rate constant. Exponential processes with large values of rate constant decay or grow faster.

- When \( k \) is positive, a function of the form \( C = C_0 e^{kt} \), increases monotonically and represents exponential growth (Figure 13.1). Exponential growth describes the growth of many bacteria, cell cultures and tumors.

- An exponential function with negative exponent of the form: \( C = C_0 e^{-kt} \) decreases monotonically and represents exponential decay (Figure 1). Exponential decay describes the drug stability and the pharmacokinetics of many drugs when administered intravenously.

- The \( k \) is called the rate constant. It has units of time\(^{-1}\). The reciprocal of the rate constant is called the time constant \( \tau \).

\[
\tau = \frac{1}{k}
\]

- The half-life \( T_{1/2} \) is the time interval over which the exponential decay process reaches one-half of its original value.

\[
T_{1/2} = \frac{\ln 2}{k}
\]
Some general rules:

<table>
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<tr>
<th>( \log_b 1 = 0 )</th>
<th>( \log_b (xy) = \log_b x + \log_b y )</th>
<th>( \log_b \frac{x}{y} = \log_b x - \log_b y )</th>
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<tr>
<td>( \log_b x^n = n \log_b x )</td>
<td>( \log_a x = \log_a \frac{x}{\log_a b} )</td>
<td>( \log_x = \log_a a \log_a x )</td>
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</table>

**GRAPHING**

- Remember the goal of all graphing is to obtain information and to communicate data.
- Most graphing is now conducted in computer programs. Familiarize yourself with a graphing program and its features. Learn how obtain effective graphs with these programs and to fit regression lines and obtain equations.
- The goal of the graphing exercises in this Workbook is to improve your ability to interpret graphs more effectively. Do not use a computer program for these exercises.

**Linear graphs – Dos and Don’ts**

- I am assuming that you are fairly familiar with linear graphs.
- The equation for a linear graph is of the general form: \( y = mx + c \)
- The constant \( m \) is the slope, and the constant \( c \) is the intercept.
- Select the horizontal axis for the independent variable and the \( y \)-axis for the dependent variable.
- Always label axes with both the variables and the units.
- Choose ticks marks that are reasonable and if possible round numbers to avoid errors and to speed calculations.
- Do not leave huge empty spaces. Adjust the range of the axes so that the graph occupies almost all the graph paper.
- All the data points should be visible. Use a distinct circle, square or other symbol to identify data points.
- Slope and equation should be calculated from the line, not the data points. Slopes calculated from points that are far apart are more accurate from points that are closely spaced.

**Semi-Log Graphing**

- Used to plot exponential functions. The \( x \)-axis has a linear scale whereas the \( y \)-axis is marked according to a logarithmic scale.
- Any function of the form \( y = A e^{bx} \) yields a straight line on semi-log graph paper. The numbers \( A, b \) and \( c \) are constants.
- The basis for the linearity is shown below by taking logarithms on both sides:

\[
\log y = \log A + (k \log c)x
\]

- Semi log graph paper has a logarithmic scale on one axis and a linear scale on the other.
Since the y-axis is a log axis, this equation is of the form that represents a straight line ($y = mx + c$).

- The constant $A$, can be calculated from the intercept, and the rate constant $k$, can be calculated from the slope (which equals $k \log c$).

- Unlike linear graphs, you cannot arbitrarily assign values to a $y$-axis. You should learn how to label the axes. The labels change by an order of magnitude in each cycle, e.g., if the first cycle is labeled 1, 2, 3,..., 9, the next cycle is labeled 10, 20, 30,...90.

- The slope of the graph is determined using the formula:

$$Slope = \frac{\log y_2 - \log y_1}{x_2 - x_1}$$
Problem 3

a. Will the equation \( y = 15x + 3.14 \) result in a straight line on semi-log graph paper?

b. Will the equation \( y = 15x^4 \) result in a straight line on semi-log graph paper?

c. Will the equation \( y = 15e^{22x} \) result in a straight line on semi-log graph paper?

d. Will the equation \( y = 15e^{-\pi x} \) result in a straight line on semi-log graph paper?

e. Will the equation \( y = 15 \cdot 2^{22x} \) result in a straight line on semi-log graph paper?

f. Will the equation \( y = (15e^{-\pi x})^3 \) result in a straight line on semi-log graph paper?

g. Will the equation \( y = 15^x e^{-\pi x} \) result in a straight line on semi-log graph paper?
**Problem 4**

a. A pharmacist in a drug company is studying the effects of two drugs, Abracabradabramycin and Gobledygookmycin, on tumor growth. Tumor size (as a percent of initial tumor size) in the presence of these drugs was measured as function of time (in days). The relationships obtained after a systematic experimental study were well summarized by the following exponential equations:

- **Abracabradabramycin**  
  \[ \%\text{Size} = 100e^{0.1t} \]
- **Gobledygookmycin**  
  \[ \%\text{Size} = 100e^{0.05t} \]

Which of these two drugs inhibits tumor growth? Why?

b. A medicinal chemist has synthesized two previously unknown antibiotics, gibberishcillin and baloneycillin, which decay in aqueous solution according to the following exponential equations. Identify the drug that decays more rapidly.

- **Gibberishcillin**  
  \[ \% \text{Remaining Intact} = 100e^{-0.03t} \]
- **Baloneycillin**  
  \[ \% \text{Remaining Intact} = 100e^{-0.1t} \]

Identify the drug that decays more rapidly.
Problem 10

An oncologist has 3 patients, Patient A, Patient B, and Patient C. She is monitoring the progress of their brain tumors using magnetic resonance imaging (MRI), which allows the volume of the tumors to be measured. She analyzes the volumes of the tumor as a function of time (t) and identifies the following relationship:

Patient A  Tumor volume $V_A = 2500 e^{0.05t}$
Patient B  Tumor volume $V_B = 1200 e^{0.1t}$
Patient C  Tumor volume $V_C = 3600 e^{-0.005t}$

a. Which tumor is growing at the fastest rate?

b. Which patient currently has the largest tumor?

c. Whose tumor is most likely to decrease with time?
Problem 11
A scientist is comparing three antibiotics. He sets up an experiment to test their efficacy by monitoring their effect on the growth of *Streptococcus pneumoniae*, the bacterium that causes pneumonia. In the presence of the same concentration of the three drugs, the bacterial count (N) follows the following relationships

\[
\begin{align*}
\text{Anathemamycin} & \quad N_A = 1 \times 10^8 e^{-2t} \\
\text{Bugkillamycin} & \quad N_B = 1 \times 10^8 e^{-5t} \\
\text{Clinicamycin} & \quad N_C = 1 \times 10^8 e^{-0.0005t}
\end{align*}
\]

a. Consider only Anathemamycin and Bugkillamycin. Which is the more effective antibiotic.

b. Which antibiotic is best described as a bacteriostatic, i.e., it prevents the multiplication of bacteria but does not kill bacteria?
Problem 12
The following Figures contain the $Y$-axes of semi-logarithmic graphs with a single labeled tick. Use the information to label the ticks marked with the filled circles.
**Problem 16**

Glibenclamide is a poorly soluble, oral hypoglycemic drug that is used for patients with non-insulin dependent diabetes. Savolainen et al. (*Pharmaceutical Research*, 15, 11, 1998, 1696) studied the pharmacokinetics of intravenously administered glibenclamide prior to comparing various dosage forms. The following graph describes the kinetics of glibenclamid elimination.

![Graph showing the kinetics of glibenclamide elimination](image)

**Diagram: Glibenclamide Elimination**

- **Glibenclamide Concentration, ng/ml**
- **Time, hours**

**Table:**

<table>
<thead>
<tr>
<th>Time, hours</th>
<th>Glibenclamide Concentration, ng/ml</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>10000</td>
</tr>
<tr>
<td>2</td>
<td>1000</td>
</tr>
<tr>
<td>4</td>
<td>100</td>
</tr>
<tr>
<td>6</td>
<td>10</td>
</tr>
<tr>
<td>8</td>
<td>1</td>
</tr>
</tbody>
</table>

a. Calculate the slope of the graph.

b. What are units of the slope?
c. Calculate the rate constant from the graph.

_____________________

d. What is the concentration of drug at time $t = 0$?

_____________________

e. State the equation that describes the elimination of glibenclamide.

_____________________

f. From the graph, determine the half-life of glibenclamide elimination.

_____________________

Problem 17

As many of you are aware, computers and microprocessors have revolutionized healthcare and pharmacy. Some of these changes can be attributed to the rapid increase in the speeds of microprocessors and a statement informally called Moore’s law, which states:

“the number of transistors on a chip will double every two years”

Gordon Moore, the Chairman of Intel Corp., made this prediction in 1975 and it has proven uncannily prophetic. In fact, if Moore’s law applied to automobiles, a car would cost less than a dollar today!

Given: a Pentium II chip had $7.5 \times 10^6$ transistors in 1997.

a. Fill in the following Table using Moore’s law

<table>
<thead>
<tr>
<th>Year</th>
<th>Number of Transistors/chip</th>
</tr>
</thead>
<tbody>
<tr>
<td>1997</td>
<td>$7.5 \times 10^6$</td>
</tr>
<tr>
<td>1995</td>
<td></td>
</tr>
<tr>
<td>1993</td>
<td></td>
</tr>
<tr>
<td>1989</td>
<td></td>
</tr>
</tbody>
</table>

b. Plot Moore’s law for the period on semi-logarithmic graph paper for the period 1980 to 2000. Use at least 4 points.

________________________

c. Does Moore’s law follow a straight line on semi-log graph paper?

________________________

d. If your answer to (c) is yes, what does it mean?

________________________

e. Calculate the slope of the graph.

________________________
Problem 21

The concentration of an antibiotic, ceftriaxone, after an intravenous bolus in a newborn infant is described by the following graph (U.B. Schaad, W.L. Hayton and K. Stoeckel, Clinical Pharmacology and Therapeutics, 37, 522, 1985).

a. Does this graph represent a growth or decay process?

b. Is this plot on linear or semi-log paper?

c. What is the initial concentration of drug in the experiment?
d. What is the slope of the straight line?

__________________________


e. What is the rate constant?

__________________________

f. Write the equation that describes the findings of the experiment. Use the numbers that you obtained from the graph.

__________________________

g. Determine the half-life of ceftriaxone from the graph.

__________________________
e. Determine the intercept.

f. What is the equation of the line?
**Problem 23**

A novel genetically engineered monoclonal antibody, Daclizumab, is an effective immunosuppressive agent that reduces the risk of rejection (F. Vicenti et al., *New England Journal of Medicine*, 338, 161, 1998). The concentration of Daclizumab decreases according to an exponential function and the drug has a half-life of 20 days in humans. At time $t = 0$, the concentration in blood of patient Jane Doe is 20 µg/ml.

a. What is the concentration at time $t = 20$ days?

b. If the initial concentration of daclizumab in blood is 20 µg/ml, what is the concentration at time $t = 40$ days.

c. Set up and label the linear axis of the semi-log graph paper to plot Daclizumab concentrations between time $t = 0$ and $t = 80$ days.

d. Set up and label the semi-log axis of the semi-log graph paper to plot Daclizumab concentrations between time $t = 0$ and $t = 80$ days.

e. Plot the graph using at least 3 points. Draw a straight line through the points.

   See graph

f. Determine the slope of the graph from the plot.

g. Determine the rate constant from the slope.
Problem 30

The following table shows experimental data from a study evaluating the stability of a new solid preparation of ertapenem in aqueous solutions (pH: 7.4, 37°C).

<table>
<thead>
<tr>
<th>Time, days</th>
<th>Concentration µg/ml</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>$3.00 \times 10^4$</td>
</tr>
<tr>
<td>5</td>
<td>$8.18 \times 10^3$</td>
</tr>
<tr>
<td>15</td>
<td>607</td>
</tr>
<tr>
<td>30</td>
<td>12.3</td>
</tr>
<tr>
<td>40</td>
<td>0.91</td>
</tr>
</tbody>
</table>

a. Plot the points and draw the line that fits the data. Label both axes, indicate units and clearly indicate data points to obtain credit.

_________________________

b. Calculate the slope of the straight line from the graph.

_________________________

c. Calculate ertapenem’s decay constant. Indicate units.

_________________________

d. From the graph, determine the time necessary for ertapenem concentration to reach 100 µg/ml (Indicate the extrapolated value both in the graph and below to obtain credit).

_________________________

e. From the graph, determine the time necessary for ertapenem concentration to reach 90% of the initial concentration (Indicate the extrapolated value both in the graph and below to obtain credit).

_________________________

f. Indicate the exponential equation that describes the decay of ertapenem in aqueous solution. Indicate units and mathematical signs.

_________________________
f. Indicate the exponential equation that describes the decay of ertapenem in aqueous solution. Indicate units and mathematical signs.

\[ C \text{ in } \mu g/ml = 3 \times 10^4 e^{-0.25 \times \text{time in days}} \]
NOTES

Outline
• Rationale
• Radioactivity, Definitions of units
• Radiation, Definitions of units
• Law of radioactive decay

Rationale
• Radiochemicals used as pharmaceuticals in diagnosis.
• Radiation is used in cancer chemotherapy.
• Radiation e.g., X-rays and positron emission used in imaging.
• Radioactive materials are widely used in research.
• Of course, radioactive materials are commonly used in military applications and energy production.

Radioactivity Units
• Radioactivity is caused by the spontaneous decay of unstable nuclei.
• There are two units of activity the Curie and the SI unit, the Becquerel.
• The Curie (Ci) is based on the decay of 1 gram of radium.
• The SI unit, the Becquerel (Bq) equals 1 disintegration per second (1 dps).
• 1 Ci = $3.7 \times 10^{10}$ Bq
• The Becquerel is a relatively small unit and terms such as megabecquerel (MBq), gigabecquerel (Gbq) and terabecquerel are used to describe commonly used levels of radioactivity.
• The Curie is a relatively small unit and terms such as millicurie (mCi), and microcurie (µCi) are used to describe commonly used levels of radioactivity.
• The Becquerel will probably ultimately replace the Curie.
• The specific activity of a radioactive material or preparation is the activity per milliliter or gram. Its is used for dosing calculations and has units of Ci/ml, Ci/g, Bq/ml, Bq/g etc.

Radiation Units
• The Roentgen (R) is a measure of radiation exposure.
• 1 Roentgen (R) is defined as the amount of X or gamma rays that produces 1 electrostatic unit of charge in air at standard temperature and pressure.
• The rad or radiation absorbed dose is equal to an energy exposure of 100 ergs/gram
• The SI unit for absorbed dose is the Gray (Gy) equal to 1 Joule/kg.
• 1 Roentgen = 0.93 rad
• 1 Gray = 100 rads
• The Rem (Roentgen equivalent man) is unit of radiation dose equivalent or exposure that takes into account the differing biological effect of different forms of radiation.
• Rems = Rads × Quality Factor
• Quality Factors

<table>
<thead>
<tr>
<th>Radiation</th>
<th>Quality factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>X rays, gamma rays and beta particles</td>
<td>1</td>
</tr>
<tr>
<td>Slow neutrons</td>
<td>3</td>
</tr>
<tr>
<td>Fast neutrons</td>
<td>20</td>
</tr>
<tr>
<td>Alpha particles</td>
<td>20</td>
</tr>
</tbody>
</table>

• The SI unit of for dose equivalent is Sievert and equals 1 Joule/kg. 1 Sievert = 100 Rem

Law of Radioactive Decay
• The rate of decay is proportional to the number of atoms present.
• Mathematically,
  \[ \frac{dN}{dt} = -\lambda N \]
  \( \lambda \) is the rate constant for decay. \( \lambda \) has units of time\(^{-1}\). \( t \) is the time, \( N \) is the number of radioactive nuclei present.
• The differential equation can be integrated to give:
  \[ N = N_0 e^{-\lambda t} \]
  \( N_0 \) is the initial number of radioactive nuclei present.
• The differential equation can be written in terms of \( f \), the fraction of the initial activity remaining to give:
  \[ f = \frac{N}{N_0} = e^{-\lambda t} \]

Half-Life And Its Relationship to the Decay Constant
• The half-life (\( T_{1/2} \)) of a radionuclide is time required for half of the initial radioactivity to decay.
• The half-life (\( T_{1/2} \)) is related to the decay constant:
  \[ \frac{1}{2} = e^{-\lambda T_{1/2}} \]

Taking natural logarithms on both sides:
Problem 2
a. What causes radioactivity?

b. State the SI unit of radioactivity.

____________________

c. State a unit that is used to measure the amount of radiation absorbed.

____________________

d. State a unit that is used to measure the biological effects of absorbed radiation.

____________________
Sodium iodide I-123 is a radiochemical. It is used for thyroid function testing because it accumulates in the thyroid and the radiation emitted can be detected with imaging devices. Because it is a radiochemical, Sodium iodide I-123 activity decays with time. The percent activity remaining as a function of time is shown in the graph on the following page.

a. Calculate the volume of the solution that should be injected.

_____________________________

b. What is the slope of the graph.

_____________________________

c. From the graph, calculate the half-life for the sodium iodide I-123.

_____________________________

d. What is the equation of the graph shown?

_____________________________

e. The shipping delay between the manufacturer and your hospital is 36 hours. Calculate the specific activity that should be shipped so that you receive 2 mCuries/ml.

_____________________________
Activity of Sodium Iodide I-123

Percentage of Activity Remaining

Time, hours

0 12 24 36 48 60 72
Problem 5

Tc 99 lidofenin contains radioactive technetium (Tc 99) and is used imaging the liver in patients with hepatobiliary disease.

The radioactive compound is prepared by adding Tc99 sodium pertechnetate to 10 mg of lidofenin complexed with stannous chloride. The lidofenin complexed with stannous chloride is not radioactive; all the radioactivity is provided by Tc99 sodium pertechnetate. After adding the Tc99 sodium pertechnetate the preparation is qs-ed to a total volume 10 ml.

a. Express the dose in Becquerels

b. The rate constant for the decay of Technetium is 0.1151 hr\(^{-1}\). Determine the half-life.

c. The specific activity of the Tc99 sodium pertechnetate you have is 20 mCi/ml. What volume of Tc99 sodium pertechnetate should you add to lidofenin complexed with stannous chloride?

d. What is the concentration of Tc-99 radioactivity in the final preparation? Give your answer in mCi/ml

e. What volume of preparation should be injected?
**Problem 8**

<table>
<thead>
<tr>
<th>Name</th>
<th>Chad Ballot</th>
<th>Age</th>
<th>55</th>
<th>Height</th>
<th>130 cm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Address</td>
<td>9 Certify St, FL</td>
<td>Date</td>
<td>11/1/00</td>
<td>Weight</td>
<td>71 kg</td>
</tr>
</tbody>
</table>

**Rx**  
Inj iv 0.37 Mbq of either I-131 radioiodinated human albumin or I-125 radioiodinated human albumin

Iodine-131 has a half-life of 8.08 days. Iodine-125 has a decay constant of 0.00048 hour⁻¹.

a. Calculate the radioactive decay rate constant for iodine-131.

b. Calculate the half-life of iodine-125.

c. Write the equation that describes the loss of radioactivity from a single dose of I-125 radioiodinated albumin. Indicate the units for activity and the time variables

d. Which of the two radionuclides, I-125 or I-131, decays faster?

e. What percent of the initial radioactivity will remain if the I-125 radioiodinated albumin dosage form is unused for 14 days.

f. Convert the dose to curies
Problem 9

Dr. Hunter Gatherer, M.D.
5 Fisherman’s Wharf
Bakersfield, CA

<table>
<thead>
<tr>
<th>Name</th>
<th>Age</th>
<th>Height</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ed Ucator</td>
<td>55</td>
<td>130 cm</td>
</tr>
</tbody>
</table>

Address: 25 University Av, Bakersfield
Date: 8/18/97
Weight: 71 kg

Inject 0.2 mCi of 0.1 mCi/ml Cr-51 sodium chromate iv for diagnosis of GI blood loss.

H. Gatherer, MD

Chromium-51 sodium chromate has a half-life of 27.7 days.

a. Express the dose in Becquerels

b. Calculate the volume of sodium chromate solution to be injected.

c. The specific activity of the Cr-51 sodium chromate is 10 mCi/mg. What is the concentration of sodium chromate in percent strength?

d. Calculate the decay constant for Cr-51 sodium chromate.

e. If the shipping delay is 10 days, calculate the activity in mCi/ml of Cr-51 sodium chromate that should be shipped to provide 0.1 mCi/ml at the time of injection.
NOTES

Outline

• Rationale
• Definitions of density, specific gravity and specific volume
• Measuring density and specific gravity
• Archimedes principle and density and specific gravity measurements
• Powders and bulk density
• Problems

Definitions And Concepts

• Density ($\rho$) is the mass per unit volume of substance.
• Density has dimensions of mass/volume and units such as $g/cm^3$, $g/ml$, $kg/m^3$, lbs/ft$^3$, grains/fluid ounce.
• Specific gravity (SG) is density of the substance relative to the density of a reference substance, water. Equivalently, specific gravity is the ratio of the weight of the substance to weight of an equal volume of water.
• Specific gravity is a pure number and is nondimensional.
• Specific volume (SV) is the ratio of the volume of a given mass of the substance to volume of an equal mass of water.
  \[ SV = \frac{1}{SG} \]
• Specific volume, like specific gravity, is nondimensional.
• The density of water at 4°C is 1.000 g/ml.
• Therefore, the numerical value of volume of water (in ml or cm$^3$) is the same as the weight in grams.
• Also, in units of $g/ml$ or $g/cm^3$, the numerical value of the specific gravity is the same as that of density.
• Density is temperature dependent. Therefore, the temperature of measurement must accompany any density measurement.
• Calculation Example: 30 ml of glycerin weigh 37.471 g. Calculate $\rho$, SG and SV.
  \[
  \text{Density} = \rho = \frac{37.471 \text{ g}}{30 \text{ ml}} = 1.250 \text{ g/ml}
  \]
  \[
  \text{Specific Gravity} = SG = 1.250
  \]
  \[
  \text{Specific Volume} = SV = \frac{1}{1.250} = 0.8006
  \]
• Pycnometer or Specific Gravity Bottle is useful for measuring specific gravity of liquids. It is a simple device with known volume that is filled to capacity and weighed. The masses of equal volumes of the liquid of interest and water are measured. It is shown in the Figure below
Capillary

- **Calculation Example**: A 50 g pycnometer, when completely filled with an oil of unknown density weighs 94.000 g. The pycnometer when filled with water weighs 100.000 g. Calculate the specific gravity of the oil.

\[
Specific \ Gravity = SG = \frac{\text{Weight of Oil}}{\text{Weight of Water}} = \frac{94 - 50}{100 - 50} = 0.880
\]

**Archimedes’ Principle**

- A body immersed in a fluid experiences an apparent loss of weight.
- The apparent loss of weight is equal to weight of fluid displaced.
- Archimedes’ principle is widely used to determine specific gravities.
- Archimedes’ principle-based specific gravity measurements are convenient and accurate because they ingeniously eliminate volume measurements, which can introduce error. The volume measurements are substituted by weight measurements, which are more accurate. These approaches can be used to measure the density of solid objects and liquids.

**Estimating Density**

- You may occasionally have to estimate the density of a solution or suspension.
- The following common sense approach may come in handy in such estimation.
- Remember, these are estimates only. There may be situations when you need more accurate results or need actual measurements.
- **Case 1**: Dilute solutions of solids in liquids: For dilute solutions of a solid dissolved in a liquid, we can often assume that the addition of the solid does not cause a change in total volume. Thus:

\[
\text{Total mass} = \text{Mass of solvent} + \text{Mass of solute}
\]

\[
\text{Total volume} = \text{Volume of solvent}
\]

From this, density of the solution can be easily calculated.

- **Case 2**: Dilute suspensions of solids in liquids: For dilute suspensions of undissolved solid in a liquid, we can often assume that the addition of the solid causes a full change in total volume. Thus:

\[
\text{Total mass} = \text{Mass of solvent} + \text{Mass of solid}
\]

\[
\text{Total volume} = \text{Volume of solvent} + \text{Volume of solid}
\]

- From these equations, the apparent density of the suspension can be estimated, provided the volume of the solid is known or calculated.
• **Case 3: Dilute solutions, suspensions or emulsions of liquids in liquids.** The equations of Case 2 can be used for liquid in liquid solutions, emulsions and suspensions. For some liquid-in-liquid-solutions, notably alcohol in water, there can be a substantial volume change upon dissolution and it is important to realize the limitations of the approach in these situations. Which assumption are violated?

• **Case 4: Mixtures of dissolved and undissolved solids and liquids:** When a preparation contains both dissolved and undissolved materials, a combination approach can be used to estimate apparent density.

\[
\text{Total mass} = \text{Mass of all the components}
\]

\[
\text{Total volume} = \text{Volume of solvent} + \text{Volume of liquids} + \text{Volume of undissolved solids}
\]

The apparent density can be calculated from the total volume and total mass.

**Powder Density**

**Porosity of a Powder**

• A powder is porous because it has pores or void volumes in its structure. There are two kinds of voids, voids between particles and void within particles. Let \(V_b\) ve the **bulk or apparent volume** and \(V_p\) is the true volume of the particles in the powder. The **void volume** \(v\), is given by:

\[
v = V_b - V_p
\]

• The void fraction is also called the **porosity** \(\varepsilon\). It represents the fraction of the powder volume that is occupied by voids. The porosity is related to the

\[
\varepsilon = \frac{V_b - V_p}{V_b} = \frac{\rho_p - \rho_b}{\rho_p}
\]

• You have to be very specific when making references to powder density.

• The **True density**, \(\rho_p\), is the density of the solid material constituting the powder. The volume measurement takes into account only the volume occupied by the powder. It does not consider the volume of the voids.

• The **bulk density**, \(\rho_b\), is the density of the powder determined by dividing the powder mass by powder volume. The powder volume contains contributions from both the solids and from the voids between and inside granules.

• The **granule density**, \(\rho_g\), is the density of each granule. The granule volume contains contributions from the solids and the intra-particle voids. Therefore,

\[
\rho_p > \rho_g > \rho_b
\]

• The bulk density is important in determining the packaging requirements of powders. The bulk density is often 2 – 20% of the true density. Thus, if the package size of say, a foot powder, were determined based on true density you might be wrong by an order of magnitude.

• Bulk density is easy to determine. Just measure the volume of the powder in a measuring cylinder and determine its weight. Industrially it is important to control bulk density because if it too high the package will seem less full to customers and if it is too low the package cannot be filled with the powder.
Problem 3

a. State Archimedes principle.

b. Why is Archimedes principle more useful for determining the density of irregular solids than determining the density by measuring the mass and volume?

c. Championship athletes and their coaches, supermodels, and princesses are particularly concerned about body composition measurements such as muscle mass and body fat content. One of the more accurate ways of determining body fat content in humans involves weighing the subject in water and (surprisingly) the use of Archimedes principle. **Outline** the physical principle/s or steps you think might be involved in this measurement. Be very brief. Use 6 sentences or less.
Problem 4

Dr. Stoma Guardcell
156 Xylem Road
Palisade, CA

<table>
<thead>
<tr>
<th>Name</th>
<th>Age</th>
<th>Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Phloem Mesophyll</td>
<td>39</td>
<td>221 lb</td>
</tr>
</tbody>
</table>

Address: 14 Cuticle St, Palisade, CA

Date: 9/6/96

Height: 5 ft 3”

Rx 2 liters of D5W over 16 hours.

S Guardcell M.D.

a. Calculate the density of D5W.

b. Determine the D5W flow rate prescribed in ml/min.

c. Determine the D5W mass flow rate in g/min.
Problem 8

<table>
<thead>
<tr>
<th>Name</th>
<th>Susan Castanza-Ross</th>
<th>Age</th>
<th>Weight</th>
<th>Phone 555-3784</th>
</tr>
</thead>
<tbody>
<tr>
<td>Address</td>
<td>35 Central Park West, NY</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Dr. Elaine Peterman, M.D.  
1225 Newman Street, New York, NY 10226

This is a recipe for an antacid suspension. Both calcium carbonate and magnesium carbonate are insoluble in water. Calcium carbonate has a density of 2.5 g/ml and Magnesium carbonate has a density of 3 g/ml.

a. What instructions would you give the patient?

b. How many grams of calcium carbonate are required for the total preparation?

c. If you took 100 ml of the product, what volume would be occupied by the calcium carbonate?

d. If you took 100 ml of the product, what volume would be occupied by the magnesium carbonate?

e. Calculate the density of the preparation.

Calcium carbonate  500 mg/5 ml  
Magnesium carbonate  400 mg/5 ml  
Water qs  
Mft 100 ml suspension  
Sig: 15 ml bid
Problem 9

<table>
<thead>
<tr>
<th>Phone 555-3784</th>
<th>Dr. Barbie Ninja-Turtle, M.D.</th>
<th>49 Sesame Street, Barney, ND 58008</th>
</tr>
</thead>
<tbody>
<tr>
<td>Name</td>
<td>G.I Joseph</td>
<td>Age 40</td>
</tr>
<tr>
<td>Address</td>
<td>2401 Bratz Parkway, Barney, ND</td>
<td>Date 1/16/07</td>
</tr>
<tr>
<td>Rx</td>
<td>Sodium bicarbonate parenteral solution 8.4% w/v</td>
<td>Administer iv 2 mEq/kg over 4 hours</td>
</tr>
</tbody>
</table>

Sodium bicarbonate, NaHCO₃ or Na⁺(HCO₃)⁻, has a molecular weight of 84. It is an alkalinizing agent used to treat metabolic acidosis.

a. What is the valence of sodium bicarbonate?

b. What is the concentration in mEq/ml?

c. How many mEq of acid will 1 ml of this solution neutralize?

d. What is estimated density of the solution? Sodium bicarbonate is completely soluble in water.
Problem 13

Dr. Anne Lida, M.D.
3 Porifera Street
Mollusca, GA

<table>
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<th>Nema Toda</th>
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Rx
Infuse iv fat emulsion containing 10 g/100 ml of soybean oil at 1 ml/min for 30 min

Fat emulsions are used to prevent essential fatty acid depletion during total parenteral nutrition. Soyabean oil has a density of 0.9 g/ml and is insoluble in water. Fat emulsions are carefully formulated but treat this as an emulsion containing only oil and water.

a. Express the concentration of soybean oil as percentage % w/v.

b. What is the specific gravity of soybean oil?

c. If you had 100 ml of fat emulsion, what volume would be occupied by soybean oil?

d. What is the concentration of soybean oil in the preparation in % v/v?

e. Estimate the density of the preparation.
Problem 15

Unfortunately, sulfathiazole is still used in topical powders in some countries despite the risks for hypersensitivity reactions. Sulfathiazole has true density of 1.5 g/cm³ and a bulk density of 0.333 g/ml.

a. Estimate the minimum size of the container required for the powder.

b. Calculate the true volume occupied by the particles of drug. Do not include the volume of the voids.

c. Calculate the volume occupied by the voids.

d. Calculate the porosity.

e. Is the bulk density greater than or less than the granule density? Why?
Problem 16

Sodium bicarbonate has a true density of 2.033 g/ml and granule density of 1.45 g/ml.

a. Calculate the volume occupied by the solids in each tablet.

b. Calculate the apparent total volume of each tablet.

c. Calculate the volume of the voids in the tablets.

d. Calculate the porosity.

e. An intern claims to have measured the bulk density of the sodium bicarbonate powder used for making these tablets and has arrived at an answer of 1.55 g/ml. Is his measurement correct? Explain your reasoning.