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ABSTRACT

This student booklet is one of a set of eight designed to be used in a self-paced introductory chemistry course in conjunction with specified textbooks and computer-assisted instruction (CAI) modules. Each topic is introduced with a textbook reading assignment and additional readings are provided in the booklet. Also included are self-tests (and answers), CAI module assignments, and suggested breakpoints for student-teacher consultations. Supplementary learning materials, including filmstrips, are also suggested. Each booklet contains specific cognitive objectives to be met by completion. This booklet covers four major topics in measurement: scientific notation, the metric system, temperature scales, and density. (MH)

ILS CHEM PAC No. **1**

MEASUREMENT

by

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West Chester, Pennsylvania

Student No. & Name ....

Date Started ....

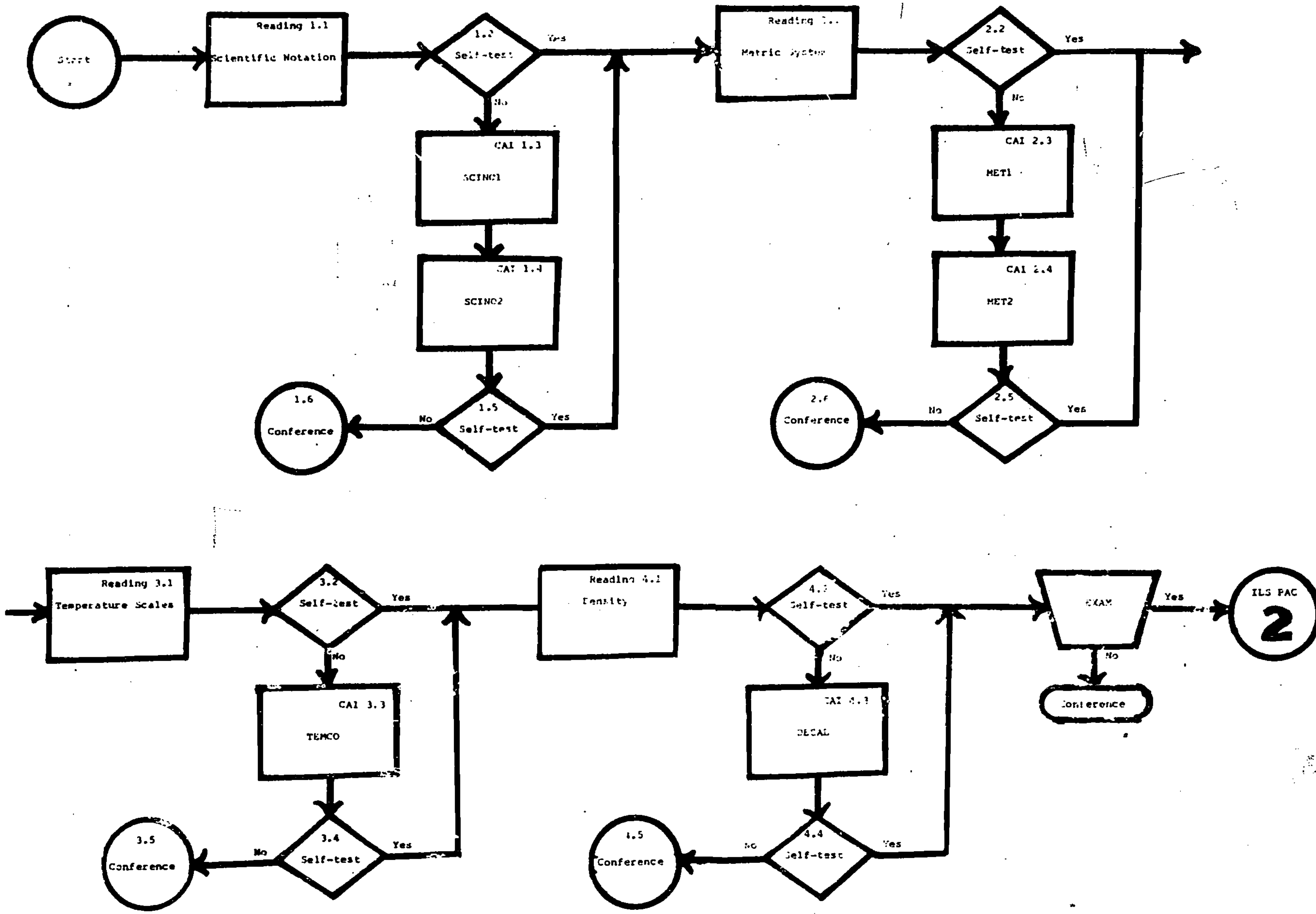
Date Completed ....

METRIC AND ENGLISH SYSTEMS AND THEIR EQUIVALENTS

m = meter	mm^2 = square millimeter	ml = milliliter
cm = centimeter	cm^2 = square centimeter	g = gram
mm = millimeter	mm^3 = cubic millimeter	mg = milligram
km = kilometer	cm^3 = cubic centimeter	kg = kilogram
	cc = cubic centimeter	

METRIC SYSTEM	ENGLISH SYSTEM	EQUIVALENTS
Length		
10 mm = 1 cm	12 in = 1 ft	1 in = 2.54 cm
100 cm = 1 m	3 ft = 1 yd	1 ft = 30.48 cm
1,000 mm = 1 m	5,280 ft = 1 mi	1 m = 39.37 in
1,000 m = 1 km		1 km = 0.62 mi
Area		
100 mm^2 = 1 cm^2	144 in^2 = 1 ft^2	1 in^2 = 6.45 cm^2
		1 ft^2 = 929 cm^2
Volume		
1,000 mm^3 = 1 cm^3 (1 cc)	1,728 in^3 = 1 ft^3	1 liter = 1.06 qt
1 ml = 1 cm^3 (1 cc)	231 in^3 = 1 gal	1 gallon = 3.78 liters
1 liter = 1,000 ml		
Mass		
1,000 mg = 1 g	16 oz = 1 lb	1 kg = 2.2 lb
1,000 g = 1 kg	2,000 lb = 1 ton	1 lb = 454 g

MEASUREMENT



OBJECTIVES

Upon completion of the ILS Chem Pac on Measurement the student should be able to

1. Scientific Notation

A. Given 10 numbers in standard notation, similar to those in reading 1.1a, convert 9 of them to scientific notation.

B. Given 10 numbers in scientific notation format, similar to those in reading 1.1b, convert 9 of them to standard notation.

C. Given 10 pairs of numbers in scientific notation form, multiply or divide 9 of them as indicated in reading 1.1c.

2. Metric System

A. State the fundamental units of length, area, capacity, and mass in the metric system as well as the names and values of the most commonly used multiples in the metric system.

B. Given a table of conversion factors, calculate the metric equivalents for 13 of 15 quantities expressed in the British system--or calculate the British equivalents for 13 of 15 metric quantities. Use metric system conversions in problem solving situations.

3. Temperature Scales

Given temperatures expressed in either degrees Celsius, Fahrenheit, or Absolute, calculate the equivalent temperature on the other two scales for 9 of 10 temperatures presented.

4. Density

Apply the formula for density to calculate one of the variables when supplied with the other two in 13 of 15 density problem situations.

Reading 1.1a - Read the footnote on page 18 in Medeiros and pages 561-563 in Holum.
Notes:

Reading 1.1b

In any chemistry course very large and very small numbers are expressed exponentially. Very large or very small numbers are expressed as 10 raised to some power. A power, or exponent, tells how many times a number is repeated as a factor. Thus:

10^2 (ten repeated as a factor 2 times) = 10 x 10 = 100

10^3 (ten repeated as a factor 3 times) = 10 x 10 x 10 = 1000

10^5 (ten repeated as a factor 5 times) = 10 x 10 x 10 x 10 x 10
= 100,000

By definition, any number raised to the zero power equals 1, so 10^0 = 1. Also, by definition, a number with a negative exponent indicates the reciprocal of the same number with a positive exponent. Thus:

$$10^{-1} = \frac{1}{10^1} = \frac{1}{10} = 0.1 \quad \text{and} \quad 10^{-3} = \frac{1}{10^3} = \frac{1}{1000} = 0.001$$

Combining this in a table we have:

$10^6 = 1{,}000{,}000$	$10^{-1} = 0.1$
$10^5 = 100{,}000$	$10^{-2} = 0.01$
$10^4 = 10{,}000$	$10^{-3} = 0.001$
$10^3 = 1{,}000$	$10^{-4} = 0.0001$
$10^2 = 100$	$10^{-5} = 0.00001$
$10^1 = 10$	$10^{-6} = 0.000001$
$10^0 = 1$	

Numbers which are not integral (whole number) powers of 10 may be written as a product of two numbers, one of which is a power of 10. The other number is always written with just one figure to the left of the decimal point. Thus:

$5400 = 5.4 \times 1000 = 5.4 \times 10^3$

$627 = 6.27 \times 100 = 6.27 \times 10^2$

$0.037 = 3.7 \times 0.01 = 3.7 \times 10^{-2}$

$0.00059 = 5.9 \times 0.0001 = 5.9 \times 10^{-4}$

$1{,}637{,}000 = 1.637 \times 1{,}000{,}000 = 1.637 \times 10^6$

$0.000\ 000\ 783 = 7.83 \times 0.000\ 000\ 1 = 7.83 \times 10^{-7}$

Reading 1.1c

When powers of 10 are multiplied, the exponents are added. Thus:

$$10^1 \times 10^3 = 10^{1+3} = 10^4 \text{ since } 10^1 \times 10^3 = 10 \times 1000 = 10,000 = 10^4$$

If each power itself is multiplied by some number, then in multiplication, these numbers are multiplied separately and the powers of 10 are added as before. Thus:

$$(4 \times 10^2) \times (2 \times 10^3) = (4 \times 2) \times (10^2 \times 10^3) = 8 \times 10^5$$

$$3.0 \times 10^4 \times 2.3 \times 10^{-1} = (3.0 \times 2.3) \times (10^4 \times 10^{-1}) = 6.9 \times 10^3$$

$$4.2 \times 10^5 \times 6.0 \times 10^7 = (4.2 \times 6.0) \times (10^5 \times 10^7) = 25.2 \times 10^{12}$$
$$= 2.5 \times 10^{13}$$

During division, the powers of 10 are subtracted. Thus:

$$10^4 \text{ divided by } 10^2 = 10^{4-2} \text{ since } \frac{10^4}{10^2} = \frac{10,000}{100} = 100 = 10^2$$

If each power is itself multiplied by some number, then in division these numbers are divided separately and the powers of 10 are subtracted as before. Thus:

$$\frac{4.00 \times 10^7}{3.00 \times 10^3} = \frac{4.00}{3.00} \times 10^{7-3} = \frac{4.00}{3.00} \times 10^4 = 1.33 \times 10^4$$

$$\frac{9.0 \times 10^4}{2.0 \times 10^{-6}} = \frac{9.0}{2.0} \times 10^{4-(-6)} = \frac{9.0}{2.0} \times 10^{10} = 4.5 \times 10^{10}$$

Self-test 1.2a

Express the following as a number multiplied by 10 raised to some power. (3 significant figures)

1. 5,946
2. 0.00971
3. 13,700,000
4. 0.00000732
5. 91.75
6. 0.0139
7. 0.000 000 5172
8. 0.1502
9. 98.75
10. 595,700,000

Self-test 1.2b

Change the following scientific notation numbers to the standard notation.

11. 2×10^{-5}
12. 5.1×10^{7}
13. 5.9×10^{-1}
14. 1×10^{-5}
15. 2.75×10^{-1}
16. 1.8×10^{6}
17. 1.2×10^{3}
18. 8.71×10^{2}
19. 1.44×10^{4}
20. 7.17×10^{12}

Self-test 1.2c

Perform the indicated operations.

21. $4 \times 10^{3} \times 2 \times 10^{5}$
22. $(3.0 \times 10^{2})^{3}$
23. $6.2 \times 10^{-4} \div 3 \times 10^{5}$
24. $8.2 \times 10^{-4} \div 6.1 \times 10^{-5}$
25. $4.1 \times 10^{5} \times 3.2 \times 10^{-1}$
26. $8 \times 10^{6} \times 1 \times 10^{2}$
27. $4.5 \times 10^{-3} \div 2.1 \times 10^{2}$
28. $1.0 \times 10^{7} \div 1.5 \times 10^{-2}$
29. $2 \times 10^{5} \times 1 \times 10^{3}$
30. $7.5 \times 10^{-6} \div 3.5 \times 10^{-4}$

If you missed more than one problem in either Self-test 1.2a or 1.2b, take the NO route (CAI 1.3). If you missed more than one problem in Self-test 1.2c, go directly to CAI 1.4.

CAI 1.3 - SCINO1 - Scientific Notation

This computer module gives practice in converting from standard notation to scientific notation and vice versa. Initially 8 problems are given, 4 of each type of conversion. To go on to the next module, 5 or more problems must be solved correctly. Otherwise 8 additional problems are presented for solution.

Whenever you respond to the computer in scientific notation, you must use the "E" format where E is used to represent "times ten to the power"

Example: 2.5×10^{-4} is entered as 2.5E-4

2.541×10^{3} is entered as 2.541E3

Date Completed:

CAI 1.4 - SCINO2 - Scientific Notation

Drill and practice in multiplying and dividing in scientific notation. Initially 8 problems are given, 4 of each type. To go on to the next module, more than half of the problems must be solved correctly. Otherwise 8 additional problems are presented for solution.

You must observe the same convention with respect to the "E" format as you did in SCINO1 -- which is the prerequisite for this module.

Date Completed:

Self-test 1.5

CAI 1.3 will also count as the Self-test for objectives 1A and 1B. Five or more of the 8 problems presented must be solved correctly.

CAI 1.4 will also count as the Self-test for objective 1C. Four or more of the 8 problems presented must be solved correctly.

Conference (1.5)

If you are still having difficulty with scientific notation at this point, please see your instructor.

Date:

Notes:

Reading 2.1 - Read pages 10-12 in Medeiros, pages 5-7 in Sackheim & Schultz, and pages 5 & 6 in Holum.
Notes:

The fundamental unit of length in the metric system is the .... (1); the fundamental unit of area is the .... (2); the fundamental unit of capacity is the .... (3); and the unit of mass is the .... (4).

The main advantage of the metric system is that it is a decimal system in which the units are all multiples of ten--larger or smaller than some other unit. A meter can be divided into ten parts, each of which is called a .... (5). The prefix .... (6) indicates one-tenth. Each tenth part of a meter can, in turn, be divided into ten parts, each of which is called .... (7). This is one-hundredth of a meter. The prefix .... (8) indicates one-hundredth. Each of these parts can, in turn, be divided into ten parts, each of which is called a .... (9). This is one-thousandth of a meter. The prefix .... (10) indicates one-thousandth. Ten meters is equal to a .... (11). The prefix .... (12) indicates ten. One thousand meters is equal to a .... (13). The prefix .... (14) indicates one thousand. These prefixes retain the same meaning when used with other units such as grams or liters.

Because each of these prefixes does refer to a multiple of ten, you can easily convert from grams to kilograms or milligrams by simply moving the decimal point. 687 grams = ... (15) kilograms = ... (16) milligrams.

Likewise, 1500 milliliters = ... (17) centiliters = ... (18) deciliters = ... (19) kiloliters = ... (20) liters.

2378 meters = ... (21) kilometers = ... (22) decimeters = ... (23) centimeters = ... (24) millimeters.

The answers to Reading 2.1 are:

1. meter	9. millimeter	17. 150
2. square meter	10. milli	18. 15
3. liter	11. decameter	19. 0.0015
4. kilogram	12. deca	20. 1.5
5. decimeter	13. kilometer	21. 2.378
6. deci	14. kilo	22. 23,780
7. centimeter	15. 0.687	23. 237,800
8. centi	16. 687,000	24. 2,378,000

Self-test 2.2

There are 39.37 inches in a meter. Therefore, 1 inch = ... (1) cm. There are 2.2 pounds in a kilogram. Therefore, 1 pound = ... (2) gram. There are 1.06 quarts in 1000 milliliters. Therefore, 1 quart = ... (3) liter.

To convert 25.0 pounds to grams, we must multiply by .... (4) g/lb because there are many more g than lb. The answer is .... (5) g.

To convert 5.00 yards to meters, we first change yards to feet and then to inches. Since there are more cm than in, we multiply by .... (6) cm/in. But the problem asked for m, so we convert cm to m by dividing by 100 since there are 100 cm to a m. The answer is .... (7) m.

To convert 200 gallons to liters, we first change gallons to quarts and multiply by .... (8) l/g. The answer is .... (9) l.

To convert 6.81 kg to lb, we first change kg to g and then divide by .... (10) g/lb. The answer is .... (11) lb.

To convert 15 dm to ft we first change dm to cm and then divide by .... (12) cm/in. The answer in feet is .... (13).

To convert 1500 ml to quarts, we first change ml to liters and multiply by .... (14) qt/l. The answer is .... (15).

If you missed more than two problems in Self-test 2.2 do the following problems on pages 9 & 10 of Sackheim & Schultz: 7, 8, 9, 10, 11 and 12; and/or take the NO route (CAI 2.3).

CAI 2.3 - MET1 - The Metric System

Use of the metric system. This is the introductory module on metric unit conversions and consists of a set of 9 problems consisting of 9 different kinds of metric conversions. To procede a minimum of 6 problems must be solved correctly. Otherwise another set of 9 problems are presented. Simple diagnostics for common errors are also presented.

The numerical answer to a problem must be given to ± 2 in the third significant figure (slide rule accuracy).

Date Completed: