



NONRESIDENT TRAINING COURSE

April 1995



Engineering Aid 3

NAVEDTRA 14069

Although the words “he,” “him,” and “his” are used sparingly in this course to enhance communication, they are not intended to be gender driven or to affront or discriminate against anyone.

COMMANDING OFFICER
NETPMSA
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04 Jun 96

ERRATA # 2

Specific Instructions and Errata for
Training Manual

ENGINEERING AID BASIC

1. This errata supersedes all previous errata.
2. No attempt has been made to issue corrections for errors in typing, punctuation, and so forth, that do not affect technical accuracy or readability.
3. Make the following changes:

<u>Page</u>	<u>Column</u>	<u>Change</u>
2-3	1	Replace "Naval Publications and Forms Center" with "Aviation Support Office"
3-11		Replace figure 3-14 with figure 3-14 A & B
3-19	2	Replace "DOD-STD-100C" with "MIL-STD-100E"
5-7		Replace figure 5-12 with figures 5-11 and 5-12
7-17	1	Replace figure 7-22 with figures 7-21 and 7-22
14-19		Replace caption in figure 14-20 with "Sample field notes from cross-section leveling at first three stations shown in figure 14-17."
14-28	2	Replace 1200/3.7 with 3.7/1200
14-28	2	Replace 800/-5.0 with -5.0/800

DRAWING FORMATS

Drawing format is the systematic space arrangement of required information within the drafting sheet. This information is used to identify, process, and file drawings methodically. Standard sizes and formats for military drawings are arranged according to DoD-STD-100C, *Engineering Drawing Practices*, and MIL-HDBK-1006/1, *Policy and Procedures for Project Drawing and Specification Preparation*. With the exception of specific local command requirements, DoD-STD-100C and MIL-HDBK-1006/1 are your guidelines for preparing SEABEE drawings.

Most of the documents applicable to these standards have recently been revised and updated in order to gain like information and to share uniformity of form and language within the Naval Construction Force and between DoD organizations. Other

influencing factors are the current widespread use of reduced-size copies of both conventional and computer-generated drawings and exchange of microfilm.

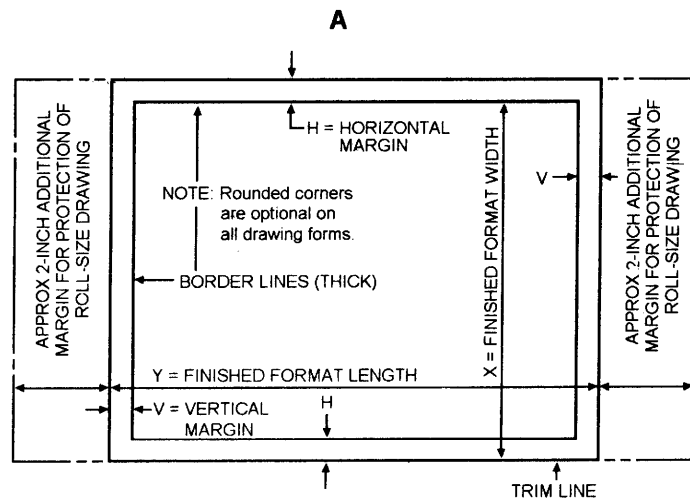
SHEET SIZES

Standard drawing sheet sizes are used to facilitate readability, reproduction, handling, and uniform filing. Blueprints produced from standard size drawing sheets are easily assembled in sets for project stick files and can readily be folded for mailing and neatly filed in project letter size or legal size folders. (Filing drawings and folding blueprints will be covered later in this training manual.)

Finished format sizes for drawings shown in figure 3-14, view A, are according to ANSI Y14.1

FLAT SIZES					ROLL SIZES					
SIZE DESIGNATION LETTER	X (WIDTH)	Y (LENGTH)	MARGIN		SIZE DESIGNATION LETTER	X (WIDTH)	Y (LENGTH)		MARGIN	
			H (HORIZ)	V (VERT)			MIN	MAX	H (HORIZ)	V (VERT)
A (HORIZ)	8.5	11.0	0.38	0.25	G	11.0	22.5	90.0	0.38	0.50
A (VERT)	11.0	8.5	0.25	0.38	H	28.0	44.0	145.0	0.50	0.50
B	11.0	17.0	0.38	0.62	J	34.0	55.0	176.0	0.50	0.50
C	17.0	22.0	0.75	0.50	K	40.0	55.0	143.0	0.50	0.50
D	22.0	34.0	0.50	1.00						
E	34.0	44.0	1.00	0.50						
F	28.0	40.0	0.50	0.50						

NOTES: 1. ADDITIONAL PROTECTION MARGINS FOR ROLL SIZE DRAWINGS ARE NOT INCLUDED IN ABOVE DIMENSIONS.
2. ALL DIMENSIONS ARE IN INCHES.



84NP0082

Figure 3-14.—Guide for preparing horizontal and vertical margins, sizes, and finished drawing format.

45.857

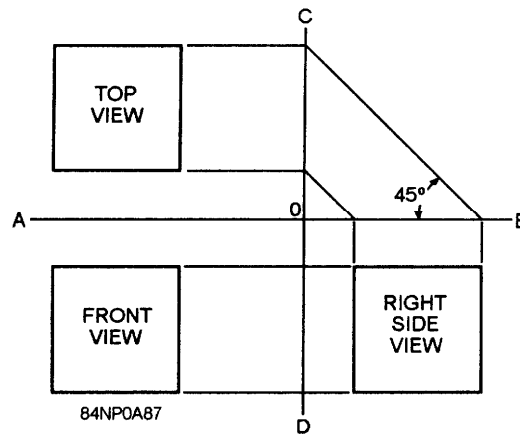


Figure 5-11.—Alternative method of extending to top view projection lines.

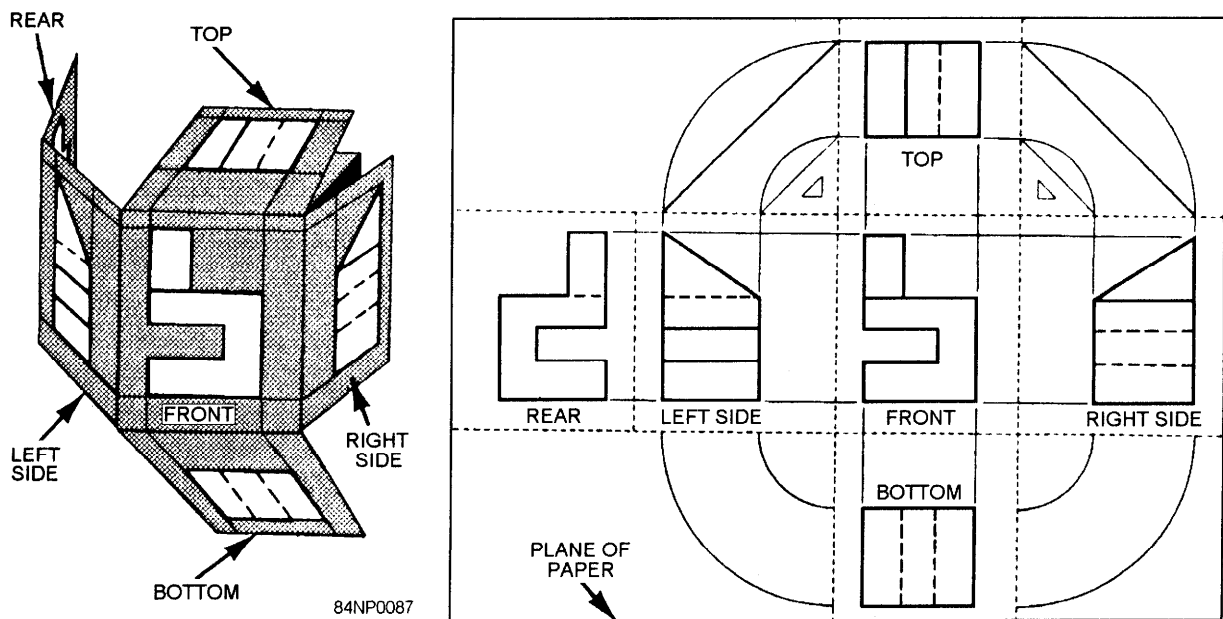


Figure 5-12.—American standard arrangement of views in a six-view third-angle multi-view projection.

view always lies in the plane of the drafting surface and does not require any rotation. Notice that the front, right side, left side, and rear views line up in direct horizontal projection.

Use the minimum number of views necessary to show an item. The three principal views are the top, front, and right-side. The TOP VIEW (also called a PLAN in architectural drawings) is projected to and drawn on an image plane above the front view of the

object. The FRONT VIEW (ELEVATION) should show the most characteristic shape of the object or its most natural appearance when observed in its permanent or fixed position. The RIGHT-SIDE VIEW (ELEVATION) is located at a right angle to the front and top views, making all the views mutually perpendicular.

SPACING OF VIEWS.— Views should be spaced on the paper in such a manner as

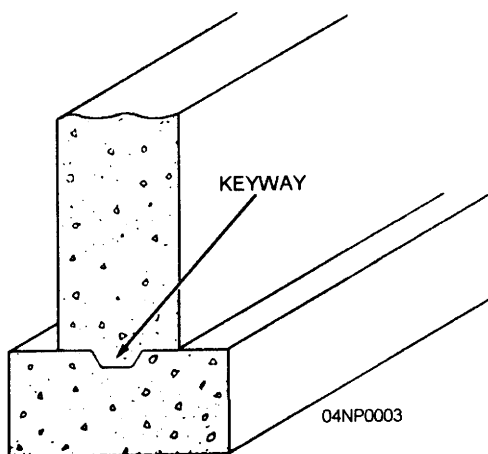


Figure 7-21.—Construction joint between wall and footing with a keyway.

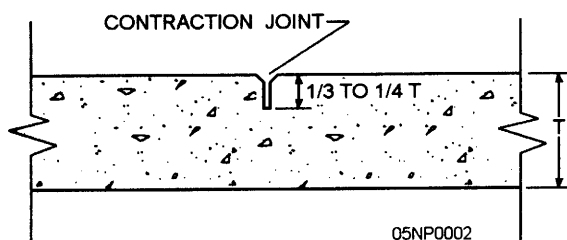


Figure 7-22.—Use of a contraction joint.

incident to shrinkage of the concrete. Atypical dummy contraction joint (fig. 7-22) is usually formed by cutting a depth of one third to one fourth the thickness of the section. Some contracting joints are made with no filler or with a thin coat of paraffin or asphalt and/or other materials to break the bond. Depending on the extent of local temperature, joints in reinforced concrete slabs may be placed at 15- to 25-ft intervals in each direction.

Expansion Joints

Wherever expansion might cause a concrete slab to buckle because of temperature change, expansion joints (also called isolation joints) are required. An expansion joint is used with a pre-molded cork or mastic filler to separate sections from each other, thus allowing room for expansion if elongation or closing of the joint is anticipated. Figures 7-23, 7-24, and 7-25 show

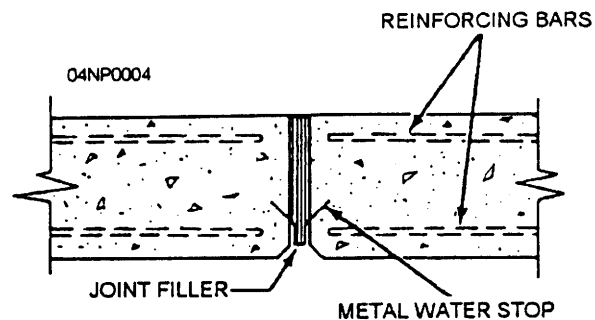


Figure 7-23.—Expansion joint for a wall.

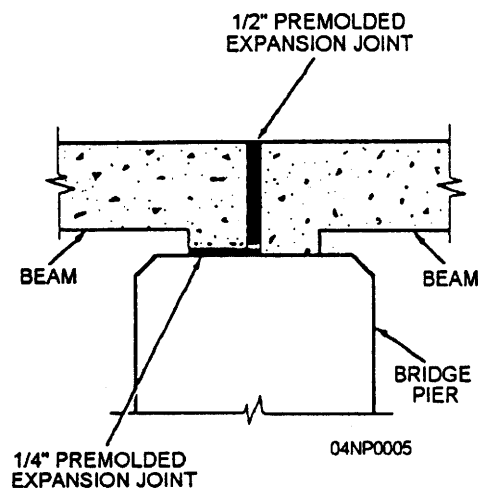


Figure 7-24.—Expansion joint for a bridge.

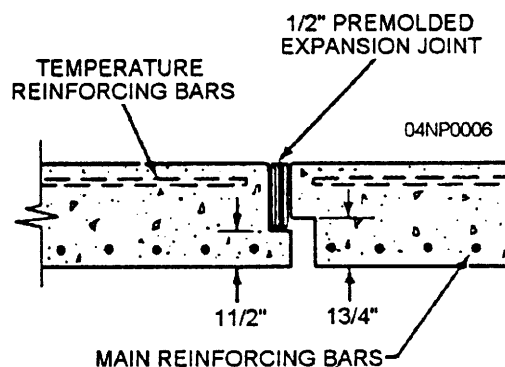


Figure 7-25.—Expansion joint for a floor slab.

expansion joints for a variety of locations. Expansion joints may be installed every 20 ft.

CONCRETE FORMS

Most structural concrete is made by placing (also called CASTING) plastic concrete into

PREFACE

By enrolling in this self-study course, you have demonstrated a desire to improve yourself and the Navy. Remember, however, this self-study course is only one part of the total Navy training program. Practical experience, schools, selected reading, and your desire to succeed are also necessary to successfully round out a fully meaningful training program.

THE COURSE: This self-study course is organized into subject matter areas, each containing learning objectives to help you determine what you should learn along with text and illustrations to help you understand the information. The subject matter reflects day-to-day requirements and experiences of personnel in the rating or skill area. It also reflects guidance provided by Enlisted Community Managers (ECMs) and other senior personnel, technical references, instructions, etc., and either the occupational or naval standards, which are listed in the *Manual of Navy Enlisted Manpower Personnel Classifications and Occupational Standards*, NAVPERS 18068.

THE QUESTIONS: The questions that appear in this course are designed to help you understand the material in the text.

VALUE: In completing this course, you will improve your military and professional knowledge. Importantly, it can also help you study for the Navy-wide advancement in rate examination. If you are studying and discover a reference in the text to another publication for further information, look it up.

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Sailor's Creed

"I am a United States Sailor.

I will support and defend the
Constitution of the United States of
America and I will obey the orders
of those appointed over me.

I represent the fighting spirit of the
Navy and those who have gone
before me to defend freedom and
democracy around the world.

I proudly serve my country's Navy
combat team with honor, courage
and commitment.

I am committed to excellence and
the fair treatment of all."

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CREDITS

The illustration indicated below is included in this edition of *Engineering Aid Basic* through the courtesy of the designated company. Permission to use this illustration is gratefully acknowledged.

SOURCE

ELE International, Inc.

FIGURE

15-28

INSTRUCTIONS FOR TAKING THE COURSE

ASSIGNMENTS

The text pages that you are to study are listed at the beginning of each assignment. Study these pages carefully before attempting to answer the questions. Pay close attention to tables and illustrations and read the learning objectives. The learning objectives state what you should be able to do after studying the material. Answering the questions correctly helps you accomplish the objectives.

SELECTING YOUR ANSWERS

Read each question carefully, then select the BEST answer. You may refer freely to the text. The answers must be the result of your own work and decisions. You are prohibited from referring to or copying the answers of others and from giving answers to anyone else taking the course.

SUBMITTING YOUR ASSIGNMENTS

To have your assignments graded, you must be enrolled in the course with the Nonresident Training Course Administration Branch at the Naval Education and Training Professional Development and Technology Center (NETPDTC). Following enrollment, there are two ways of having your assignments graded: (1) use the Internet to submit your assignments as you complete them, or (2) send all the assignments at one time by mail to NETPDTC.

Grading on the Internet: Advantages to Internet grading are:

- you may submit your answers as soon as you complete an assignment, and
- you get your results faster; usually by the next working day (approximately 24 hours).

In addition to receiving grade results for each assignment, you will receive course completion confirmation once you have completed all the

assignments. To submit your assignment answers via the Internet, go to:

<http://courses.cnet.navy.mil>

Grading by Mail: When you submit answer sheets by mail, send all of your assignments at one time. Do NOT submit individual answer sheets for grading. Mail all of your assignments in an envelope, which you either provide yourself or obtain from your nearest Educational Services Officer (ESO). Submit answer sheets to:

COMMANDING OFFICER
NETPDTC N331
6490 SAUFLEY FIELD ROAD
PENSACOLA FL 32559-5000

Answer Sheets: All courses include one “scannable” answer sheet for each assignment. These answer sheets are preprinted with your SSN, name, assignment number, and course number. Explanations for completing the answer sheets are on the answer sheet.

Do not use answer sheet reproductions: Use only the original answer sheets that we provide—reproductions will not work with our scanning equipment and cannot be processed.

Follow the instructions for marking your answers on the answer sheet. Be sure that blocks 1, 2, and 3 are filled in correctly. This information is necessary for your course to be properly processed and for you to receive credit for your work.

COMPLETION TIME

Courses must be completed within 12 months from the date of enrollment. This includes time required to resubmit failed assignments.

PASS/FAIL ASSIGNMENT PROCEDURES

If your overall course score is 3.2 or higher, you will pass the course and will not be required to resubmit assignments. Once your assignments have been graded you will receive course completion confirmation.

If you receive less than a 3.2 on any assignment and your overall course score is below 3.2, you will be given the opportunity to resubmit failed assignments. **You may resubmit failed assignments only once.** Internet students will receive notification when they have failed an assignment--they may then resubmit failed assignments on the web site. Internet students may view and print results for failed assignments from the web site. Students who submit by mail will receive a failing result letter and a new answer sheet for resubmission of each failed assignment.

COMPLETION CONFIRMATION

After successfully completing this course, you will receive a letter of completion.

ERRATA

Errata are used to correct minor errors or delete obsolete information in a course. Errata may also be used to provide instructions to the student. If a course has an errata, it will be included as the first page(s) after the front cover. Errata for all courses can be accessed and viewed/downloaded at:

<http://www.advancement.cnet.navy.mil>

STUDENT FEEDBACK QUESTIONS

We value your suggestions, questions, and criticisms on our courses. If you would like to communicate with us regarding this course, we encourage you, if possible, to use e-mail. If you write or fax, please use a copy of the Student Comment form that follows this page.

For subject matter questions:

E-mail: n314.products@cnet.navy.mil
Phone: Comm: (850) 452-1001, Ext. 1754
DSN: 922-1001, Ext. 1754
FAX: (850) 452-1370
(Do not fax answer sheets.)
Address: COMMANDING OFFICER
NETPDTC (CODE N314)
6490 SAUFLEY FIELD ROAD
PENSACOLA FL 32509-5237

For enrollment, shipping, grading, or completion letter questions

E-mail: fleetservices@cnet.navy.mil
Phone: Toll Free: 877-264-8583
Comm: (850) 452-1511/1181/1859
DSN: 922-1511/1181/1859
FAX: (850) 452-1370
(Do not fax answer sheets.)
Address: COMMANDING OFFICER
NETPDTC (CODE N331)
6490 SAUFLEY FIELD ROAD
PENSACOLA FL 32559-5000

NAVAL RESERVE RETIREMENT CREDIT

If you are a member of the Naval Reserve, you will receive retirement points if you are authorized to receive them under current directives governing retirement of Naval Reserve personnel. For Naval Reserve retirement, this course is evaluated at 20 points. These points will be credited in units as follows:

Unit 1 - 12 points upon satisfactory completion of Assignments 1 through 8

Unit 2 - 8 points upon satisfactory completion of Assignments 9 through 13

(Refer to *Administrative Procedures for Naval Reservists on Inactive Duty*, BUPERSINST 1001.39, for more information about retirement points.)

COURSE OBJECTIVES

In completing this nonresident training course, you will demonstrate a knowledge of the subject

matter by correctly answering questions on the following subjects: Mathematics and Units of Measurement; Drafting Equipment; Drafting: Fundamentals and Techniques; Drafting: Geometric Construction; Drafting: Projections and Sketching; Reproduction Process; Wood and Light Frame Structures; Concrete and Masonry; Mechanical Systems and Plan; Electrical Systems and Plan; Construction Drawings; Elements of Surveying and Surveying Equipment; Direct Linear Measurements and Field Survey Safety; Horizontal Control; Direct Leveling and Basic Engineering Surveys; Materials Testing: Soil and Concrete; and Administration.

Student Comments

Course Title: Engineering Aid 3

NAVEDTRA: 14069 **Date:** _____

We need some information about you:

Rate/Rank and Name: _____ SSN: _____ Command/Unit _____

Street Address: _____ City: _____ State/FPO: _____ Zip _____

Your comments, suggestions, etc.:

Privacy Act Statement: Under authority of Title 5, USC 301, information regarding your military status is requested in processing your comments and in preparing a reply. This information will not be divulged without written authorization to anyone other than those within DOD for official use in determining performance.
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NETPDTC 1550/41 (Rev 4-00)

CHAPTER 1

MATHEMATICS AND UNITS OF MEASUREMENT

Mathematics is the Engineering Aid's basic tool. The use of mathematics is found in every rating in the Navy, from the simple arithmetic of counting for inventory purposes to the complicated equations encountered in computer and engineering designs. In the Occupational Field 13 ratings, the Engineering Aid is looked upon as superior in knowledge when it comes to the subject of mathematics, which generally is a correct assumption; however, to be worthy of this calling, you have the responsibility to learn more about this subject. Mathematics is a broad science that cannot be covered fully in formal service school training, so it is up to you to devote some of your own time to the study of this subject.

The EA must have the ability to compute easily, quickly, systematically, and accurately. This requires a knowledge of the fundamental properties of numbers and the ability to estimate the accuracy of computations based on field measurements or collected field data. To compute rapidly, you need constant practice and should be able to use any available device to speed up and simplify computations. In solving a mathematical problem, you should take a different approach than you would if it were simply a puzzle you were solving for fun. Guesswork has no place in its consideration, and the statement of the problem itself should be devoid of anything that might obscure its true meaning. Mathematics is not a course in memory but one in reasoning. Mathematical problems should be read and so carefully analyzed that all conditions are well fixed in mind. Avoid all unnecessary work and shorten the solution wherever possible. Always apply some proof or check to your work. Accuracy is of the greatest importance; a wrong answer is valueless.

This chapter covers various principles of mathematics. The instructions given will aid the EA in making mathematical computations in the field and the office. This chapter also covers units of measurement and the conversion from one

system to the other; that is, from the English to the metric system.

FUNDAMENTALS OF MATHEMATICS

MATHEMATICS is, by broad definition, the science that deals with the relationships between quantities and operations and with methods by which these relationships can be applied to determine unknown quantities from given or measured data. The fundamentals of mathematics remain the same, no matter to what field they are applied. Various authors have attempted to classify mathematics according to its use. It has been subdivided into a number of major branches. Those with which you will be principally concerned are arithmetic, algebra, geometry, and trigonometry.

ARITHMETIC is the art of computation by the use of positive real numbers. Starting with the review of arithmetic, you will, by diligent effort, build up to a study of algebra.

ALGEBRA is the branch of mathematics that deals with the relations and properties of numbers by means of letters, signs of operation, and other symbols. Algebra includes solution of equations, polynomials, verbal problems, graphs, and so on.

GEOMETRY is the branch of mathematics that investigates the relations, properties, and measurement of solids, surfaces, lines, and angles; it also deals with the theory of space and of figures in space.

TRIGONOMETRY is the branch of mathematics that deals with certain constant relationships that exist in triangles and with methods by which they are applied to compute unknown values from known values.

STUDY GUIDES

Mathematics is an exact science, and there are many books on the subject. These numerous

books are the result of the mathematicians' efforts to solve mathematical problems with ease. Methods of arriving at solutions may differ, but the end results or answers are always the same. These different approaches to mathematical problems make the study of mathematics more interesting, either by individual study or as a group.

You can supplement your study of mathematics with the following training manuals:

1. *Mathematics, Vol. 1*, NAVEDTRA 10069-D1
2. *Mathematics, Vol. 2-A*, NAVEDTRA 10062
3. *Mathematics, Vol. 2-B*, NAVEDTRA 10063
4. *Mathematics, Vol. 3*, NAVEDTRA 10073-A1

TYPES OF NUMBERS

Positive and negative numbers belong to the class called REAL NUMBERS. Real numbers and imaginary numbers make up the number system in algebra. However, in this training manual, we will deal only with real numbers unless otherwise indicated.

A real number may be rational or irrational. The word *rational* comes from the word *ratio*. A number is rational if it can be expressed as the quotient, or ratio, of two whole numbers. Rational numbers include fractions like $\frac{2}{7}$, whole numbers (integers), and radicals if the radical is removable. Any whole number is rational because it could be expressed as a quotient with 1 as its denominator. For instance, 8 equals $\frac{8}{1}$, which is the quotient of two integers. A number like $\sqrt{16}$ is rational since it can be expressed as the quotient of the two integers in the form $\frac{4}{1}$. An irrational number is a real number that cannot be expressed as the ratio of two integers. The numbers

$$\sqrt{3}, \quad 5\sqrt{2}, \quad \sqrt{7+5}, \quad \frac{3}{8}\sqrt{20}, \quad \sqrt{\frac{3}{5}}$$

and 3.1416 (π) are examples of irrational numbers.

An integer may be prime or composite. A number that has factors other than itself and 1 is a composite number. For example, the number 15 is composite. It has the factors 5

and 3. A number that has no factors except itself and 1 is a prime number. Since it is advantageous to separate a composite number into prime factors, it is helpful to be able to recognize a few prime numbers. The following are examples of prime numbers: 1, 2, 3, 5, 7, 11, 13, 17, 19, and 23.

A composite number may be a multiple of two or more numbers other than itself and 1, and it may contain two or more factors other than itself and 1. Multiples and factors of numbers are as follows: Any number that is exactly divisible by a given number is a multiple of the given number. For example, 24 is a multiple of 2, 3, 4, 6, 8, and 12 since it is divisible by each of these numbers. Saying that 24 is a multiple of 3, for instance, is equivalent to saying that 3 multiplied by some whole number will give 24. Any number is a multiple of itself and also of 1.

FRACTIONS, DECIMALS, AND PERCENTAGES

The most general definition of a fraction states that "a fraction is an indicated division." Any division may be indicated by placing the dividend over the divisor with a line between them. By the above definition, any number, even a so-called "whole" number, may be written as a common fraction. The number 20, for example, may be written as $\frac{20}{1}$. This or any other fraction that amounts to more than 1 is an IMPROPER fraction. For example, $\frac{8}{3}$ is an improper fraction. The accepted practice is to reduce an improper fraction to a mixed fraction (a whole number plus a proper fraction). Perform the indicated division and write the fractional part of the quotient in its lowest term. In this case, $\frac{8}{3}$ would be $2\frac{2}{3}$. A fraction that amounts to less than 1 is a PROPER fraction, such as the fraction $\frac{1}{4}$.

To refresh your memory, we are including the following rules in the solution of fractions:

1. If you multiply or divide both the numerator and denominator of a fraction by the same number, the value does not change. The resulting fraction is called an EQUIVALENT fraction.

2. You can add or subtract fractions only if the denominators are alike.

3. To multiply fractions, simply find the products of the numerators and the products of the denominators. The resulting fractional product must be reduced to the lowest term possible.