



**NONRESIDENT
TRAINING
COURSE**

May 1999



Construction Mechanic Basic, Volume 2

NAVEDTRA 14273

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.

PREFACE

By enrolling in this self-study course, you have demonstrated a desire to improve yourself and the Navy. Remember, however, this selfstudy course is only one part of the total Navy training program. Practical experience, schools, selected reading, and your desire to succeed are also necessaryto 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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SUMMARY OF CONSTRUCTION MECHANIC BASIC

VOLUME 1

Construction Mechanic Basic, Volume 1, NAVEDTRA 14264, consists of chapters on Technical Administration; Principles of an Internal Combustion Engine; Construction of an Internal Combustion Engine; Gasoline Fuel Systems; Diesel Fuel Systems; and Cooling and Lubricating Systems.

VOLUME 2

Construction Mechanic Basic, Volume 2, NAVEDTRA 14273, consists of chapters on Basic Automotive Electricity; Automotive Electrical Circuits and Wiring; Hydraulic and Pneumatic Systems; Automotive Clutches, Transmissions, and Transaxles; Drive Lines, Differentials, Drive Axles, and Power Train Accessories; Construction Equipment Power Trains; Brakes; and Automotive Chassis and Body.

SAFETY PRECAUTIONS

Safety is a paramount concern for all personnel. Many of the Naval Ship's Technical Manuals, manufacturer's technical manuals, and every Planned Maintenance System (PMS) maintenance requirement card (MRC) include safety precautions. Additionally, OPNAVINST 5100.19 (series), Naval Occupational Safety and Health (NAVOSH) Program Manual for Forces Afloat, and OPNAVINST 5100.23 (series), NAVOSH Program Manual, provide safety and occupational health information. The safety precautions are for your protection and to protect equipment. Cautions and warnings of potentially hazardous situations or conditions are highlighted, where needed, in each chapter of this TRAMAN. Remember to be safety conscious at all times.

During equipment operation and preventive or corrective maintenance, the procedures may call for personal protective equipment (PPE), such as goggles, gloves, safety shoes, hard hats, hearing protection, and respirators. When specified, use of PPE is mandatory. You must select PPE appropriate for the job since the equipment is manufactured and approved for different levels of protection. Most machinery, spaces, and tools requiring you to wear hearing protection are posted with hazardous noise signs or labels. Eye hazardous areas requiring you to wear goggles or safety glasses are also posted. In areas where corrosive chemicals are mixed or used, an emergency eyewash station must be installed. Anytime a procedure does not specify the PPE, and you are not sure, ask your safety officer.

All lubricating agents, oil, cleaning material, and chemicals used in maintenance and repair are hazardous materials. Examples of hazardous materials are gasoline, coal distillates, and asphalt. Gasoline contains a small amount of lead and other toxic compounds. Ingestion of gasoline can cause lead poisoning. Coal distillates, such as benzene or naphthalene in benzol, are suspected carcinogens. Avoid all skin contact and do not inhale the vapors and gases from these distillates. Asphalt contains components suspected of causing cancer. Anyone handling asphalt must be trained to handle it in a safe manner.

Hazardous materials require careful handling, storage, and disposal. OPNAVINST 4110.2 (series), *Hazardous Material Control and Management*, contains detailed information on the hazardous material program. Additionally, PMS documentation provides hazard warnings or refers the maintenance man to the Hazardous Materials User's Guide. Material Safety Data Sheets (MSDS) also provide safety precautions for hazardous materials. All commands are required to have an MSDS for each hazardous material they have in their inventory; therefore, additional information is available from your command's Hazardous Material Coordinator.

Recent legislation and updated Navy directives implemented tighter constraints on environmental pollution and hazardous waste disposal. OPNAVINST 5090.1 (series), *Environmental and Natural Resources Program Manual*, provides detailed information. Your command must comply with federal, state, and local environmental regulations during any type of construction or demolition. Your supervisor will provide training on environmental compliance.

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. 1826
DSN: 922-1001, Ext. 1826
FAX: (850) 452-1370
(Do not fax answer sheets.)
Address: COMMANDING OFFICER
NETPDTC (CODE 314)
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 12 points. (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: Basic Automotive Electricity; Automotive Electrical Circuits and Wiring; Hydraulic and Pneumatic Systems; Automotive Clutches, Transmissions, and Transaxles; Drive Lines, Differentials, Drive Axles, and Power Train Accessories; Construction Equipment Power Trains; Brakes; and Automotive Chassis and Body.

Student Comments

Course Title: Construction Mechanic Basic, Volume 2

NAVEDTRA: 14273 **Date:** _____

We need some information about you:

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

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

Your comments, suggestions, etc.:

<p>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.</p>
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NETPDTC 1550/41 (Rev 4-00)

CHAPTER 1

BASIC AUTOMOTIVE ELECTRICITY

INTRODUCTION

Learning Objective: Describe the basic principles of electrical and magnetic theory. Identify the materials, the devices, and the different types of electrical circuits. Determine electrical measurements using Ohm's law.

The basic principles of automotive electricity are the essential knowledge required by the mechanic to understand the operation of all-automotive electrical systems and components. Unless you have a clear understanding of these fundamental principles, you will find it difficult to service the various electrical components and systems encountered in the Naval Construction Force (NCF). This understanding will enable you to make sound decisions in the troubleshooting process of all electrical systems.

BASIC PRINCIPLES OF ELECTRICITY

Learning Objective: State the basic principles of electricity, the theory of electricity, and the composition of electricity and matter.

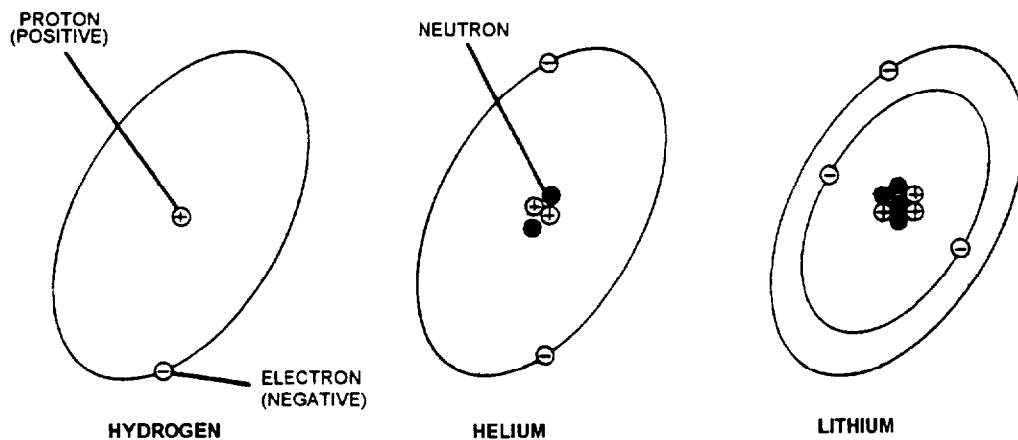
All activity that takes place in any type of electrical circuit depends on the behavior of tiny electrical charges, called electrons. To understand the behavior of electrons, we must investigate the composition of matter. The electron is one of the basic electrical components of all matter.

COMPOSITION OF MATTER

All matter, regardless of state (solids, liquids, and gases), is made up of tiny particles, known as atoms. Atoms combine in small groups of two or more to form molecules; however, when atoms are divided, smaller particles are created. These particles have positive or negative electrical charges.

There are over 100 different basic materials in the universe. These basic materials are called elements. Iron is one element; copper, aluminum, oxygen, hydrogen, and mercury are examples of elements. The basic particles that make up all the elements, and thus the entire universe, are called protons, electrons, and neutrons. A proton is the basic particle having a single positive charge; therefore, a group of protons produces a positive electrical charge. An electron is the basic particle having a single negative charge; therefore, a group of electrons produces a negative electrical charge. A neutron is the basic particle having no charge; therefore, a group of neutrons would have no charge.

The construction of atoms of the various elements can be examined starting with the simplest of all—hydrogen. The atom of hydrogen consists of one proton, around which is circling one electron (fig. 1-1). There is an attraction between the two particles, because negative and positive electrical charges always attract each other. Opposing the attraction between the two particles, and thus preventing the



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Figure 1-1.—Composition of matter.

electron from moving into the proton, is the centrifugal force on the electron caused by its circular path around the proton. This same sort of balance is produced if a ball tied to string was whirled in a circle in the air. The centrifugal force exerted tries to move the ball out of its circular path and is balanced by the string (the attractive force). If the string should break, the centrifugal force would cause the ball to fly away. Actually, this is what happens at times with atoms. The attractive force between the electron and proton sometimes is not great enough to hold the electron in its circular path and the electron breaks away.

In an atom, unlike electrical charges attract and like electrical charges repel each other. Electrons repel electrons and protons repel protons, except when neutrons are present. Though neutrons have no electrical charge, they do have the ability to cancel out the repelling forces between protons in an atomic nucleus and thus hold the nucleus together.

COMPOSITION OF ELECTRICITY

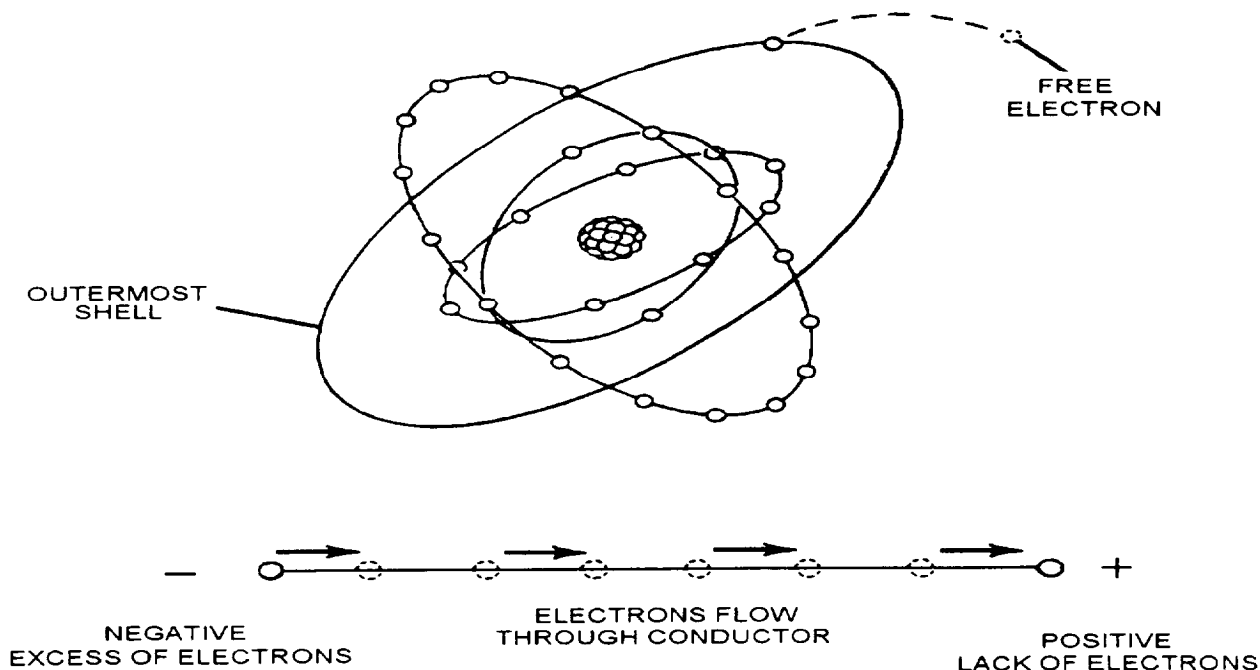
When there are more than two electrons in an atom, they move about the nucleus in different orbits (fig. 1-2) which are referred to as shells. The innermost shells of the atom contain electrons that are not easily freed and are referred to as bound electrons. The outermost shell will contain what is referred to as free electrons. These free electrons differ from bound

electrons in that they can be moved readily from their orbit.

If a point that has an excess of electrons (negative) is connected to a point that has a shortage of electrons (positive), a flow of electrons (electrical current) will flow through the connector (conductor) until an equal amount of electrical charge exists between the two points.

ELECTRON THEORY OF ELECTRICITY

A charge of electricity is formed when numerous electrons break free of their atoms and gather in one area. When the electrons begin to move in one direction (as along a wire, for example), the effect is a flow of electricity or an electric current. Actually, electric generators and batteries could be called electron pumps, because they remove electrons from one part of an electric circuit and concentrate them in another part of the circuit. For example, a generator takes electrons away from the positive terminal and concentrates them at the negative terminal. Because the electrons repel each other (like electrical charges repel), the electrons push out through the circuit and flow to the positive terminal (unlike electrical charges attract). Thus we can see that an electric current is actually a flow of electrons from a negative terminal to a positive terminal.



CMB20002

Figure 1-2.—Composition of electricity.