Tools of the Trade

Inside the Welder's Toolbox

SHOPWARE

Instructor's Guide

Introduction

This Teacher's Guide provides information to help you get the most out of *Inside the Welder's Toolbox*, part of the *Tools of the Trade* series. The contents of this guide will allow you to prepare your students before they use the program, assist them as they navigate through the program, and present follow-up activities to reinforce the program's key learning points.

Tools of the Trade is a 6-part series of programs that present inventories of the most common and most basic tools used in specific trades. Each program opens the trade's "toolbox" so students can delve into its basic tools and materials, including their purpose and proper usage. Students will view brief demonstrations of rudimentary tasks with the tools, and gain an understanding of safety precautions, code concerns, and industry tips, if applicable.

Inside the Welder's Toolbox is a 27-minute video targeted to students (vocational students, in particular) in grades 9-12. Its content is appropriate to such curriculum areas as Technology Education, Trade, and Industrial Education. In addition, the information presented in *Tools of the Trade* could also be presented in vocational/technical schools or "Do it Yourself" adult education courses.

The *Tools of the Trade* series consists of the following titles:

- *Inside the Plumber's Toolbox*
- *Inside the Carpenter's Toolbox*
- *Inside the Mason's Toolbox*
- *Inside the Welder's Toolbox*
- *Inside the Automotive Technician's Toolbox*
- *Inside the Electrician's Toolbox*

Learning Objectives

After watching this video program, students will be able to:

- Identify and understand basic safety standards used when welding, including proper attire and gear, and how to work safely when welding.
- Explain various ways to help identify metals.
- Identify the general tools used during welding.
- Identify the three main welding processes of SMAW, GMAW, and GTAW, including their alternate names and acronyms, main components and equipment, advantages and disadvantages, and additional safety precautions to consider for each specific welding process.
- Recognize and explore welding career opportunities.

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Educational Standards

This program correlates to all National CTE Organizational Standards (including the provisions of the Perkins Act). In addition, it correlates with:

- The America Welding Society's Content Standards;
- The Program Certification Standards for Automobile Technician Training Programs from the National Institute for Automotive Service Excellence (ASE) and the National Automotive Technicians Education Foundation (NATEF);
- The competency standards for Core Introductory Craft Skills from the National Center for Construction Education & Research (NCCER);
- The NOCTI/SkillsUSA Examination Standards;
- The standards for Basic Skills (Mathematics) and Thinking Skills (Visualization) from the Secretary's Commission on Achieving Necessary Skills (SCANS);
- The standards of Essential Knowledge and Skills for Trade and Skills for Career Orientation, High School, for the State of Texas;
- The standards of Technology Education—Tools, Resources, and Technological Processes, for the State of New York.

The content has been aligned with the Architecture and Construction Career Cluster, the Manufacturing Career Cluster, and with the following educational standards from the organizations listed below.

NATIONAL STANDARDS

The content has been aligned with the following educational standards, which reflect the tasks in the ASE Program Certification Standards for Automobile General Service Technician Programs.

Metal Welding

- Determine correct welding process in accordance with vehicle manufacturer's / industry's recommendations (GMAW [MIG], squeeze-type resistance spot), electrode, wire type, diameter, and gas to be used in specific welding situations.
- Determine proper welding technique (push, pull, and gun angle) for the type of welds being made.
- Identify the type of weld joint (butt, lap, etc.) for the repair being made.
- Use the proper gun-to-joint angle, and direction of gun travel, for welds being made in all positions.
- Insure proper work clamp (ground) location.
- Identify safety considerations: Eye protection, proper clothing, respiratory protection, shock hazards, fumes, material safety data sheet (MSDS), etc. before beginning any welding operation.

2004 Automobile Program Standards, by the National Institute for Automotive Service Excellence (ASE), copyright 2004 . Reprinted with permission.

English Language Arts Standards

The activities in this Teacher's Guide were created in compliance with the following National Standards for the English Language Arts from the National Council of Teachers of English.

- Students adjust their use of spoken, written, and visual language (e.g., conventions, style, vocabulary) to communicate effectively with a variety of audiences and for different purposes.
- Students use a variety of technological and information resources (e.g., libraries, databases, computer networks, video) to gather and synthesize information and to create and communicate knowledge.

Standards for the English Language Arts, by the International Reading Association and the National Council of Teachers of English, copyright 1996 by the International Reading Association and the National Council of Teachers of English. Reprinted with permission.

Technology Standards

The activities in this Teacher's Guide were created in compliance with the following National Education Technology Standards from the National Education Technology Standards Project.

- Demonstrate a sound understanding of the nature and operation of technology systems.
- Develop positive attitudes toward technology uses that support lifelong learning, collaboration, personal pursuits, and productivity.
- Use technology tools to enhance learning, increase productivity, and promote creativity.
- Use a variety of media and formats to communicate information and ideas effectively to multiple audiences.
- Employ technology in the development of strategies for solving problems in the real world.
- Use productivity tools to collaborate in constructing technology-enhanced models, prepare publications, and produce other creative works.
- Use telecommunications to collaborate, publish, and interact with peers, experts, and other audiences.
- Use technology to locate, evaluate, and collect information from a variety of sources.

The National Education Technology Standards reprinted with permission from the International Society of Technology Education.

INTRODUCTION TO BLUEPRINTS (MODULE 00105-00)

The student is able to recognize and identify basic blueprint terms, components, and symbols; relate information on blueprints to actual locations on the print; recognize different classifications of drawings; and interpret and use drawing dimensions.

Source: Competency Standards for Core Curriculum and Carpentry from the National Center for Construction Education & Research.

COMMUNICATION SKILLS (MODULE 00107-04)

The student is able to demonstrate the ability to understand information and instructions that are presented in both written and verbal form; and demonstrate the ability to communicate effectively in on-the-job situations using written and verbal skills.

Source: Competency Standards for Core Curriculum and Carpentry from the National Center for Construction Education & Research.

Standard Number: N.SCANS.1.17.

The student is able to: imagine building, object or system by looking at a blueprint or drawing.

Source: Secretary's Commission on Achieving Necessary Skills (SCANS) Thinking Skills (Visualization).

Language Arts and Communication Standards

According to ASE/NATEF standards, the automobile technician must be proficient in the following Language Arts and Communications related academic skills that are embedded in the occupation. The activities and information presented in this program and accompanying teacher's guide are aligned to the following standards from the National Automotive Technicians Education Foundation from the National Institute for Automotive Service Excellence.

- Request, collect, comprehend, evaluate, and apply oral and written information gathered from customers, associates, and supervisors regarding problem symptoms and potential solutions to problems.
- Identify the purpose for all written and oral communication and then choose the most effective strategies for listening, reading, speaking, and writing to facilitate the communication process.
- Adapt a reading strategy for all written materials, e.g. customer's notes, service manuals, shop manuals, technical bulletins, etc., relevant to problem identification, diagnosis, solution, and repair.
- Use study habits and techniques, i.e. previewing, scanning, skimming, taking notes, etc., when reviewing publications (shop manuals, references, databases, operator's manuals, and text resources) for problem solving, diagnosis, and repair.
- Write clear, concise, complete, and grammatically accurate sentences and paragraphs.
- Follow all oral/written directions that relate to the task or system under study.
- Comprehend and apply industry definitions and specifications to diagnose and solve problems in all automotive systems and components of the automobile and light truck.
- Supply clarifying information to customers, associates, parts supplier, and supervisors.

National Automotive Technicians Education Foundation (NATEF)

COLLISION REPAIR & REFINISH STANDARDS STATEMENTS

- STANDARD 1 – The collision repair and refinish technician training program should have clearly stated program goals, related to the needs of the students and employers served.
- STANDARD 2 – Program administration should ensure that instructional activities support and promote the goals of the program.
- STANDARD 3 – Support material, consistent with both program goals and performance objectives, should be available to staff and students.
- STANDARD 6 – Instruction must be systematic and reflect program goals. A task list and specific performance objectives with criterion referenced measures must be used.
- STANDARD 7 – Equipment and tools used must be of the type and quality found in the repair industry and must also be the type needed to provide training to meet the program goals and performance objectives.
- STANDARD 8 – The physical facilities must be adequate to permit achievement of the program goals and performance objectives.
- STANDARD 9 – The instructional staff must have technical competency and meet all state and local requirements for certification.

- Standard 3.1 – Service Information Service information with current manufacturer's service procedures and specification data for vehicles manufactured within the last ten (10) years should be available. This information should be accessible to students while working in the lab/shop area.
- Standard 3.2 – Multimedia Appropriate up-to-date multimedia materials such as video equipment, transparencies, etc. should be readily available and utilized in the training process.
- Standard 3.4 – Periodicals Current general and technical collision repair and refinish magazines and newspapers should be available for student and instructor use.
- Standard 3.5 – Student Materials Necessary instructional texts or pertinent material should be available for each student to satisfy the objectives of the mode of instruction used. Basic textbooks should have copyright dates that are not over five (5) years old; specialized textbooks should have copyright dates that are not over three (3) years old.
- Standard 6.1 – Program Plan The training plan should progress in logical steps, provide for alternate sequences where applicable, and be made available to each student.
- Standard 6.2 – Student Training Plan A training plan for each student should be used indicating the student's training goal(s) and specific steps needed to meet that goal.
- Standard 6.4 – Teaching Load The instructor/student ratio and class contact hours should allow time for interaction on a one-to-one basis.
- Standard 6.5 – Curriculum All tasks have been given a priority rating. At least 95% of the High Priority - Individual (HP-I) and 90% of the High Priority — Group (HP-G) items in the Task List must be included in the curriculum. Additional tasks may be included to meet the needs of local employers. The Advisory Committee should approve all additional tasks. Instruction on the legal aspects and responsibilities of the collision repair and refinish technician in areas such as Environmental Protection Agency regulations, safety regulations, OSHA regulations (including the ruling on respiratory protection), and other appropriate requirements should be included in the curriculum. Instruction and practice in filling out work order forms, ordering parts, and basic record keeping should be a part of the training program. Tools and equipment must be available 4 to perform the tasks in each of the areas in which certification is requested.
- Standard 6.7 – Performance Standards All instruction should be performance based, with an acceptable performance standard stated for each task. These standards should be shared with students and potential employers. Students should demonstrate "hands-on competency" or "mastery" of a task before the instructor verifies a student's performance.

- Standard 6.8 – Safety Standards Safety instruction should be given prior to lab/shop work and be an integral part of the training program. A safety test should be included in the training program. Students and instructors should comply with personal and environmental safety practices associated with clothing; respiratory protection; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with local, state, and federal safety and environmental regulations.
- Standard 6.14 – Evaluation of Instruction Instructional procedures should be evaluated in a systematic manner. This evaluation should be through regular reviews by students and the administration. Self-evaluation of instruction should also be utilized on a systematic and regular basis. This system should include input from former students and from the Advisory Committee members. Instructional procedures should show responsiveness to the feedback from these evaluations.
- Standard 7.1 – Safety Equipment and tools used in the training program must have all shields, guards, and other safety devices in place, operable, and used. Safety glasses must be worn by all students, instructors, and visitors in the lab/shop area while lab is in session.
- Standard 7.2 – Quantity and Quality The tools and equipment used in the training program should reflect the program goals and performance objectives. Sufficient tools and equipment should be available for the training offered. The tools and equipment should meet industry quality standards.
- Standard 7.5 – Replacement A systematic schedule for replacement should be used to maintain up-to-date tools and equipment at industry and safety standards. Student follow-up and Advisory Committee input should be used in this system.
- Standard 8.2 – Safety The facilities should meet all applicable safety standards and an emergency plan should be in place and posted in all classrooms and lab/shops areas.
- Standard 8.3 – Maintenance A regular facilities maintenance program should be used to assure facilities are suitable when required for instruction.
- Standard 9.1 – Technical Competency The instructor must hold current ASE certification in each collision repair and refinish area they teach and which is being evaluated for program certification.
- Standard 9.2 – Instructional Competency/Certification Instructors should meet all state certifying requirements.
- Standard 9.3 – Technical Updating Faculty members should be provided technical materials required to maintain their competency. An opportunity should be provided for instructors to return to industry on a regular basis for in-service and skill upgrading.
- Standard 9.4 – First Aid The program should have a written policy, approved by the administrator of the school, on First Aid procedures.

Career Standards

This program also correlates with the National Career Development Guidelines from the National Occupational Information Coordinating Committee. The content has been aligned with the following standards from this organization.

- Understand the relationship between educational achievement and career planning.
- Demonstrate how to apply academic and vocational skills to achieve personal goals.
- Describe the relationship of academic and vocational skills to personal interests.
- Describe how skills developed in academic and vocational programs relate to career goals.
- Describe how learning skills are required in the workplace.
- Locate, evaluate, and interpret career information.
- Describe the educational requirements of various occupations.
- Identify how employment trends relate to education and training.
- Demonstrate academic or vocational skills required for a full or part-time job.
- Demonstrate employability skills necessary to obtain and maintain jobs.
- Understand how societal needs and functions influence the nature and structure of work.
- Describe how occupational and industrial trends relate to training and employment.
- Describe career plans that reflect the importance of lifelong learning.
- Demonstrate knowledge of postsecondary vocational and academic programs.

The National Career Development Guidelines reprinted with permission from the Center for Civic Education.

NCCER STANDARDS

BASIC SAFETY (MODULE 00101-00)

- Identify the responsibilities and personal characteristics of a professional craftsperson.
- Explain the role that safety plays in the construction crafts.
- Describe what job-site safety means.
- Explain the appropriate safety precautions around common job-site hazards.
- Demonstrate the use and care of appropriate personal protective equipment.
- Follow safe procedures for lifting heavy objects.
- Describe safe behavior on and around ladders and scaffolds.
- Explain the importance of the HazCom (Hazard Communication Standard) requirement and MSDSs (Material Safety Data Sheets).
- Describe fire prevention and fire fighting techniques.
- Define safe work procedures around electrical hazards.

WELDING SAFETY (MODULE 29101-03)

- Identify some common hazards in welding.
- Explain and identify proper personal protection used in welding.
- Demonstrate how to avoid welding fumes.
- Explain some of the causes of accidents.
- Identify and explain uses for material safety data sheets.
- Demonstrate safety techniques for storing and handling cylinders.
- Explain how to avoid electric shock when welding.
- Demonstrate proper material handling methods.

BASE METAL PREPARATION (MODULE 29103-03)

- Clean base metal for welding or cutting.
- Identify and explain joint design.
- Explain joint design considerations.
- Using a nibbler, cutter, or grinder, mechanically prepare the edge of a mild steel plate 1/4" to 3/4" thick at 22 1/2° (or 30° depending on equipment available).
- Using a nibbler, cutter, or grinder, mechanically prepare the end of a pipe with a 30° or 37 1/2° bevel (depending on equipment available) and a 3/32" land. Use 6", 8", or 10" Schedule 40 or Schedule 80 mild steel pipe.
- Select the proper joint design based on a welding procedure specification (WPS) or instructor direction.

SMAW – EQUIPMENT AND SETUP (MODULE 29105-03)

- Identify and explain shielded metal arc welding (SMAW) safety.
- Identify and explain welding electrical current.
- Identify and explain arc welding machines.
- Explain setting up arc welding equipment.
- Set up a machine for welding.
- Identify and explain tools for weld cleaning.

SHIELDED METAL ARC ELECTRODES AND SELECTION (MODULE 29106-03)

- Identify factors that affect electrode selection.
- Explain the American Welding Society (AWS) and the American Society of Mechanical Engineers (ASME) filler metal classification system.
- Identify different types of filler metals.
- Explain the storage and control of filler metals.
- Explain filler metal traceability requirements and how to use applicable code requirements.
- Identify and select the proper electrode for an identified welding task.

SMAW – BEADS AND FILLET WELDS (MODULE 29107-03)

- Set up shielded metal arc welding (SMAW) equipment.
- Describe methods of striking an arc.
- Properly strike and extinguish an arc.
- Describe causes of arc blow and wander.
- Make stringer, weave, and overlapping beads.
- Make fillet welds in the following positions: Horizontal (2F), Vertical (3F), and Overhead (4F).

WELDING SYMBOLS (MODULE 29201-03)

- Identify and explain the various parts of a welding symbol.
- Identify and explain fillet and groove weld symbols.
- Read welding symbols on drawings, specifications, and welding procedure specifications (WPSs).
- Interpret welding symbols from a print.
- Draw welding symbols.

READING WELDING DETAIL DRAWINGS (MODULE 29202-03)

- Identify and explain a welding detail drawing.
- Identify and explain lines, material fills, and sections.
- Identify and explain object views.
- Identify and explain dimensioning.
- Identify and explain notes and bill of materials.
- Interpret basic elements of a welding detail drawing.
- Develop basic welding drawings.

SMAW – STAINLESS STEEL GROOVE WELDS & PIPES (MODULE 29203-03)

- Identify and explain stainless steel metallurgy.
- Identify and explain the selection of electrodes for welding stainless steel.
- Identify and explain welding variations for stainless steel.
- Prepare arc welding equipment for stainless steel welds.

GMAW & FCAW – EQUIPMENT AND FILLER METALS (MODULE 29206-03)

- Explain gas metal arc welding (GMAW) and flux cored arc welding (FCAW) safety.
- Explain the characteristics of welding current and power sources.
- Identify and explain the use of GMAW and FCAW equipment: Spray transfer, Globular, Short circuiting, and Pulse.
- Identify and explain the use of GMAW and FCAW shielding gases and filler metals.
- Set up GMAW and FCAW equipment and identify tools for weld cleaning.

GMAW AND FCAW – PLATE (MODULE 29207-03)

- Perform GMAW multipass fillet welds on plate, using solid or composite wire and shielding gas in multiple positions.
- Perform GMAW multipass groove welds on plate, using solid or composite wire and shielding gas in multiple positions.
- Perform GMAW spray fillet and groove welds on plate, using solid or composite wire and shielding gas in flat and horizontal positions.
- Perform FCAW multipass fillet welds on plate in multiple positions using flux cored wire and, if required, shielding gas.
- Perform FCAW multipass groove welds on plate in multiple positions using flux cored wire and, if required, shielding gas.

GTAW – EQUIPMENT AND FILLER METALS (MODULE 29208-03)

- Explain gas tungsten arc welding (GTAW) safety.
- Identify and explain the use of GTAW equipment.
- Identify and explain the use of GTAW filler metals.
- Identify and explain the use of GTAW shielding gases.
- Set up GTAW equipment.

GTAW – ALUMINUM PLATE (MODULE 29210-03)

- Identify and explain aluminum metallurgy.
- Explain and identify characteristics of aluminum.
- Explain GTAW and set up equipment to weld aluminum plate.
- Explain and practice GTAW techniques for plate and pipe, including padding in the flat position with stringer beads, using aluminum filler metal.

AWS STANDARDS

Content Standard 6.0: Students will identify, select, set up, and demonstrate the use of Shielded Metal Arc Welding (SMAW) equipment.

- Identify, list, and evaluate safety concerns common to the SMAW process.
- Identify the different components of electricity and how they relate to the welding process.
- Identify the polarities and currents used in SMAW.
- Identify and explain the different types of power sources used.
- Identify and report potential electrical safety hazards.
- Select and safely operate SMAW equipment used to complete assigned projects.
- Select appropriate electrodes to complete assignments.
- Demonstrate proper selection and use of ventilation.
- Demonstrate proper use of personal respiration.
- Demonstrate proper cleaning and joint preparation.
- Demonstrate striking an arc and running a bead.
- Demonstrate the ability to weld in the flat, horizontal, and vertical positions to complete an assigned project.

Content Standard 7.0: Students will identify, select, set up, and demonstrate the use of Gas Metal Arc Welding (GMAW) equipment.

- Identify, list, and evaluate safety concerns common to the GMAW process.
- Identify the different components of electricity and how they relate to the welding process.
- Identify the polarities, wire feed speeds, and voltages used in GMAW.
- Identify and explain the different types of power sources used.
- Identify and report potential electrical safety hazards.
- Differentiate between metal transfer methods.
- Select and safely operate GMAW equipment used to complete assigned projects.
- Select appropriate wire to complete assignments.
- Demonstrate proper selection and use of ventilation.
- Demonstrate proper use of personal respiration.
- Demonstrate proper cleaning and joint preparation.
- Demonstrate starting an arc and running a bead.
- Demonstrate the ability to weld in the flat, horizontal, and vertical positions to complete an assigned project.

Content Standard 9.0: Students will identify, select, set up, and demonstrate the use of Gas Tungsten Arc Welding (GTAW) equipment.

- Identify, list, and evaluate safety concerns common to the GTAW process.
- Identify the different components of electricity and how they relate to the GTAW process.

- Identify the polarities, currents, and modes of high frequencies used in GTAW.
- Identify and explain the different types of power sources used.
- Identify and report potential electrical safety hazards.
- Select and safely operate GTAW equipment used to complete assigned projects.
- Demonstrate proper selection and use of ventilation.
- Demonstrate proper use of personal respiration.
- Demonstrate proper cleaning and joint preparation.
- Demonstrate starting an arc and running a bead.
- Demonstrate the ability to weld in the flat, horizontal, and vertical positions to complete an assigned project.

SKILLSUSA STANDARDS

Safety

1. Demonstrate personal safety.
2. Demonstrate general shop safety.
3. Demonstrate gas, electrical, and chemical safety.
4. Demonstrate knowledge of proper actions to be taken in an emergency.

Measurements

1. Identify basic metal-working tools used in measuring.
2. Use visual measuring tools to accuracy of 1/32 inch.
3. Employ the components of a combination square set.
4. Use layout and marking tools as required.
5. Determine wire feed speed as indicated on drawing.

Blueprint Reading

1. Use information found in the information block of the drawing.
2. Read and understand three-dimensional drawings.
3. Identify the basic views used in blueprints including assembly, detail, and fit-up drawings.
4. Identify common types of lines, abbreviations, and symbols in accordance with national drawing standards.
5. Identify basic welding symbols and components of a symbol (such as arrow, reference line, tail, size, or length) in accordance with the national welding symbols standards—AWS.

Shielded Metal Arc Welding (SMAW)

1. Demonstrate safety procedures for SMAW.
2. Demonstrate ability to correctly set up SMAW power sources, related welding equipment, and do basic process and equipment troubleshooting.
3. Correctly identify base metal prior to welding.
4. Set up and shut down equipment for welding of carbon steel and/or stainless steel.
5. Select correct type of filler metal size of electrode based on carbon steel and/or stainless steel plate (1/4 inch to 1/2 inch thickness).
6. Prepare carbon steel and/or stainless steel for welding.

Gas Metal Arc Welding (GMAW)

1. Demonstrate correct safety procedures for GMAW.
2. Demonstrate ability to correctly set up GMAW power sources, related welding equipment and do basic process and equipment troubleshooting.
3. Correctly identify base metal prior to welding.
4. Set up and shut down equipment for short circuiting, globular and spray, transfer, and pulsed welding of carbon steel, stainless steel, and/or aluminum.
5. Select correct type of filler metal size of electrode, type of shielding gas, wire feed speed, and voltage based on carbon steel, stainless steel, and/or aluminum sheet and/or plate (1/16 inch to 3/8 inch thickness).
6. Prepare the carbon steel, stainless steel, and/or aluminum for welding.

Gas Tungsten Arc Welding (GTAW)

1. Demonstrate safety procedures for GTAW.
2. Demonstrate ability to correctly set up GTAW power sources, related welding equipment, and do basic process and equipment troubleshooting.
3. Correctly identify base metal prior to welding.
4. Set up and shut down equipment for regular and pulsed welding of aluminum, stainless steel, and/or carbon steel.
5. Select the correct size and type of tungsten and filler metal based on aluminum, stainless steel or carbon steel sheet, and/or plate (1/16 inch to 1/4 inch thickness).
6. Prepare aluminum, stainless steel, and/or carbon steel for welding.

Standard Number: N.CTE.2.0.

Career Cluster: Architecture and Construction Careers in designing, planning, managing, building and maintaining the built environment.

Standard Number: N.CTE.13.0.

Career Cluster: Planning, managing and performing the processing of materials into intermediate or final products and related professional and technical support activities such as production planning and control, maintenance and manufacturing/process engineering.

STATE STANDARDS

This program correlates with the following State Standards: the Career Development and Occupational Studies from the State of New York; ImagineND from the State of North Dakota; and the Texas Essential Knowledge & Skills (TEKS) for Technology Education/Industrial Technology Education from the State of Texas.

127.12. Career Connections

- The student analyzes the effect of personal interest and aptitudes upon educational and career planning. The student is expected to:
    - — complete a formal career interest and aptitude assessment;
    - — match interests and aptitudes to career opportunities; and
    - — begin a personal career portfolio by conducting an in-depth study of the varied aspects of occupations related to the student's interest areas.

- The student knows how to locate, analyze, and apply career information. The student is expected to:
    - — access career information using print and on-line resources to complete an educational and/or training plan for a career pathway;
    - — access career information using interviews with business and industry representatives to create a career resource file;
    - — complete career critiques gained through a variety of experiences (for example, shadowing, career study tours, guest speakers, career fairs, videos, CD-ROM, Internet, and simulated work activities).

Texas (Essential Knowledge and Skills for Trade and Industrial Education: Metal Technology Systems, High School)

125.65. Welding

- The student knows the employability characteristics of a successful worker in the modern workplace. The student is expected to:
    - — identify employment opportunities, including entrepreneurship, and preparation requirements in welding;
    - — demonstrate the principles of group participation and leadership related to citizenship and career preparation;
    - — identify employers' expectations and appropriate work habits;

— apply the competencies related to resources, information, systems, and technology in appropriate settings and situations; and
— demonstrate knowledge of the concepts and skills related to health and safety in the workplace, as specified by appropriate government regulations.

- The student relates core academic skills to the requirements of welding. The student is expected to:
  — demonstrate effective oral and written communication skills with individuals from varied cultures, including fellow workers, management, and customers;
  — successfully complete work orders and related paperwork;
  — estimate supplies, materials, and labor costs; and
  — read and interpret appropriate blueprints, drawings, charts, diagrams, and welding symbols.
- The student knows the concepts and skills that form the core knowledge of welding, and is expected to:
  — demonstrate knowledge of the basic theory of oxyfuel cutting, including types and uses of flames and types of fuels; and
  — demonstrate knowledge of the basic theories of shielded arc-welding, metal inert gas-welding, and tungsten inert gas-welding.
- The student knows the function and application of the tools, equipment, technologies, and materials used in welding. The student is expected to:
  — safely use hand and power tools and equipment commonly employed in welding;
  — properly handle and dispose of humanly and/or environmentally hazardous materials used in welding;
  — demonstrate knowledge of the concepts and use of numerically-controlled, computer-numerically-controlled, and robotics-controlled welding machines; and
  — demonstrate knowledge of new and emerging technologies that may affect welding.
- The student applies the concepts and skills of the trade to simulated and actual work situations. The student is expected to:
  — utilize the oxyfuel cutting process to produce freehand, straight line, pierce, and beveled cuts;
  — apply specialized cutting processes;
  — inspect and test cuts made with the oxyfuel cutting process;
  — identify the use of the common types of electrodes;
  — apply the brazing process on various metals;
  — utilize the shielded metal arc process to weld edge, lap, tee, outside corner, and grooved butt joints on metal plate in all appropriate positions;
  — utilize the shielded metal arc process to weld various pipe joints in vertical and horizontal positions;
  — utilize gas tungsten arc and gas metal arc-welding processes for basic plate welding procedures;
  — inspect and test welds; and
  — apply the knowledge and skills in welding to work-based learning experiences including, but not limited to, cooperative education, job shadowing, mentoring, and apprenticeship training programs.

New York State (Academy for Teaching and Learning: Career Development and Occupational Studies)

- Standard 1: Career Development. Students will be knowledgeable about the world of work, explore career options, and relate personal skills, aptitudes, and abilities to future career decisions.
- Standard 2: Integrated Learning. Students will demonstrate how academic knowledge and skills are applied in the workplace and other settings.
- Standard 3a: Universal Foundation Skills. Students will demonstrate mastery of the foundation skills and competencies essential for success in the workplace.
- Standard 3b: Career Majors. Students who choose a career major will acquire the career specific technical knowledge/skills necessary to progress toward gainful employment, career advancement, and success in postsecondary programs.

North Dakota State (ImagineND)

- Standard Number: N.16.0. Career Cluster: Transportation, Distribution and Logistics.
  Planning, management, and movement of people, materials, and goods by road, pipeline, air, rail and water and related professional and technical support services such as transportation infrastructure planning and management, logistics services, mobile equipment and facility maintenance.

Program Summary

Given the wide range of trades in the world today, the *Tools of the Trade* series is a welcome addition to the Shopware brand. Its overview and demonstration of the basic tools used in each trade help lay the foundation of understanding for the trades, and pique student interest in developing "do it yourself" practical knowledge that can also lead to welding as a possible career choice.

Welding is part skill, part science, fused together with safety. *Tools of the Trade: Inside the Welder's Toolbox* shows viewers the safe way to work with fire, gases, and molten metal, as it profiles the tools used in welding tasks. Three main processes are spotlighted — SMAW, GMAW, and GTAW — including alternate names and acronyms, main components and equipment, advantages and disadvantages, and additional safety precautions to consider for each specific welding process. The program also takes a look at the metals used in welding, including how to identify base materials by their characteristics, and what kinds of electrodes are available to be used as filler.

Main Topics

Topic 1: Introduction
The program's host, Alan Pratt, introduces the viewer to a brief history of welding techniques, explains how to identify metals by their characteristics, and takes a quick look at the kinds of electrodes available for various welding processes.

Topic 2: Safety Issues
This topic focuses on proper welding attire and gear, and points out crucial safety precautions to follow when welding, including work area safety and avoiding electric shock.

Topic 3: Welding Tools
This section is devoted to three important welding processes: Shielded Metal Arc Welding (SMAW), Gas Metal Arc Welding (GMAW), and Gas Tungsten Arc Welding (GTAW). The various names and acronyms associated with the processes are explained, and the main components and equipment, advantages and disadvantages, and additional safety precautions to consider for each specific welding process, are highlighted.

Topic 4: Future Outlook
The program wraps up with the future outlook for welding career opportunities, and cites some helpful resources to turn to for more information.

Fast Facts

- Artifacts from as far back as the Bronze and Iron Ages have turned up examples of pressure welding. In the Middle Ages, blacksmiths performed basic forge welding by heating and pounding metal together until joined. Today, welding with heat is used in shipbuilding, automobile manufacturing and repair, aerospace applications, joining beams in building construction and bridges, and joining pipes in pipelines, power plants, and refineries.

- About two out of every three welding jobs are in manufacturing — specifically, fabricated metal product manufacturing, transportation equipment manufacturing, machinery manufacturing, architectural and structural metals manufacturing, and construction. Welding jobs can be done manually, semi-automatically with machinery (e.g., with a wire-feeder) or completely automatically, performed autonomously by a robot or machine.

- Arc flash is like a short circuit explosion that occurs through the air, which burns the retinas in your eyes. The temperature of an arc flash can reach an astounding 35,000°F, so it is no wonder that injuries can be devastating and can even cause death. Welders need to protect themselves from this hazard by wearing a welding helmet with a dark #10 shade.

- Tungsten has the highest melting point (3,422°C; 6,192°F) and the highest tensile strength of all metals. Tungsten electrodes do not melt and are not consumed. Prior to use, they must be mechanically sharpened to a point lengthwise (not crosswise or in a circular pattern) with a grinder that is dedicated exclusively to tungsten, chemically sharpened to a point, or melted into the shape of a ball using the torch. Tungsten electrodes must be replaced whenever the tip becomes blackened or pitted, loses its point, has too large a ball, or if touched to the weld puddle or filler rod.

- Laser welding is one of the newest welding processes available today and is used for cutting metals and nonmetals alike, for automotive metalworking operations.

- Argon tends to be used more frequently than helium as a shielding gas in TIG welding because it is has a more stable arc action, allows reduced penetration into the metal, and causes a cleaning action on some metals such as aluminum and magnesium.

- SMAW electrodes can be "fast-fill" (meaning they melt quickly and allow rapid welding), "fast-freeze" (which harden quickly and allow various welding positions because the weld pool shifts less), or "fast-follow" (which follows the arc at a rapid speed). The best electrode to use should be the one that produces the weld in least amount of time.

- A fun way to improve SMAW welds is to remember the mnemonic, CLAMS: Current setting, Length of arc, Angle of electrode, Manipulation of electrode, and Speed of travel.

- Travel speed measures the arc's progress along the weld line in inches or millimeters per minute. With too slow a speed, the electrode melts on top of the weld pool and has weak penetration; with too high a speed, the heat is reduced and also results in poor penetration. But with a constant, relatively fast speed, the wire melts immediately upon touching the base metal and maximizes penetration.

- GMAW can be a noisy welding process with high frequencies. As a result, welders should always wear hearing protection such as ear muffs or plugs to prevent hearing damage or loss.

Vocabulary Terms

alternating current: Current that regularly reverses the direction of its flow. AC is often used in GTAW to weld aluminum alloys.

aluminum: A silvery white metal that is soft, light, and an effective conductor.

arc flash: A condition in which the brightness of the weld area and electric arc can burn the retinas.

arc welding: A process in which a welding power supply creates an electric arc between an electrode and the base material to melt the metals at the welding point. Either direct (DC) or alternating (AC) current, and consumable or non-consumable electrodes, are used.

argon: An inactive gas commonly used for shielding. Argon is much heavier than air, thus it effectively shields the weld area.

blueprints: Drawings that are key to understanding the type of weld that is to be made, including its location, dimensions, and depth, and any other supplementary information.

carbon dioxide: An active gas commonly used as shielding for GMAW. Carbon dioxide is inexpensive but yields a violent arc.

carpenter's framing square: A measuring tool used to check angles.

cast alloy: An aluminum alloy that is poured as a liquid into a mold and cooled into a solid shape.

c-clamp: A grasping tool used for securing metalwork while welding.

chipping hammer: A kind of tool used to chip away slag from a weld.

contact tip: The device located inside the welding gun that conducts electricity to the electrode.

copper: A reddish metal that is very ductile, thermally and electrically conductive, and corrosion resistant.

cup: A device attached to the front of the torch body on a GTAW torch that directs inert shielding gas over the weld area.

cutting torch: Power cutting tools that make quick work of cutting metal to the sizes needed for welding, preparing a metal surface, deburring a jagged metal edge, or finishing a weld. But usually the cuts will be rough.

direct current electrode negative: Direct current with straight polarity. This is often expressed as DCEN.

direct current electrode positive: Direct current with reverse polarity. This is often expressed as DCEP.

drag angle: The process of moving an electrode along the workpiece opposite the direction of welding.

duty cycle: The percentage of actual weld time that can occur in a ten-minute interval. For example, if a welder's duty cycle is 20%, actual welding can only occur for two minutes, and then the machine must cool for eight minutes. Many models feature a yellow lamp on the front that lights if the duty cycle is exceeded.

electric arc: A discharge of a gas that is electrically broken down, resulting from a current flowing through air.

electrode: A stick, rod, or wire that must also be melted as filler between the metals to help form the joint.

FCAW: The American Welding Society abbreviation for flux-cored arc welding.

ferrous: Containing iron and, generally, magnetic.

flux: A chemical composition used to conduct the electric current in soldering, brazing, and welding.

GMAW: The American Welding Society abbreviation for gas metal arc welding. Also known more specifically as metal inert gas ("MIG") welding.

grinder: A power cutting tool used to prepare a metal surface, debur a jagged metal edge, or finish a weld.

GTAW: The American Welding Society abbreviation for gas tungsten arc welding. Also known by its specific name — tungsten inert gas ("TIG") welding.

hacksaw: A tool used to cut metalwork by hand. The blade teeth cut in one direction only.

helium: An inactive gas commonly used for shielding. Helium is much lighter than air and can escape the weld area quickly.

hydrated oxide: A chemical compound containing oxygen and water.

ingot: The first solidified piece of steel from which other parts are made.

inverter: An arc welding power source that operates at very high frequencies and is much more energy efficient than transformer-based machines.

joint: The point of connection between two surfaces or metals.

liner: A material used on the inside of gun cables to decrease friction and wear from the filler wire.

locking pliers: A tool used for securing metalwork while welding.

machine welding: Welding with equipment that performs the welding operation under the observation and control of a welding operator. Machine welding is also referred to as automatic welding.

magnesium: A grayish white, extremely light metal that is brittle and has poor wear resistance. Aluminum-magnesium alloys have excellent weldability.

manganese: A hard, brittle, gray-white metal that increases the hardenability of steel. Manganese-aluminum alloys are improved through strain hardening.

non-ferrous: A material containing no iron.

oxide film: A chemical compound that contains oxygen, which forms a thin layer on the surface of metals when exposed to air. Oxide film should be removed before welding.

oxygen: A colorless, odorless, tasteless gas that naturally exists in the atmosphere. A small amount of oxygen is sometimes used for shielding. However, too much oxygen causes cracking and rusting in the metals.

polarity: The direction of current flow in a direct current (DC) circuit.

porosity: The appearance of tiny bubbles on a weld bead as a result of gas entrapment. Excessive porosity can weaken a weld.

pure tungsten electrode: A type of tungsten electrode made with 99.5 percent tungsten. Pure tungsten electrodes are primarily used with AC for welding aluminum.

push angle: Moving the electrode along the workpiece in the direction of welding. Welding aluminum with GMAW requires a push angle.

safety goggles: Personal protective equipment used to cut out 50% of the UV rays, and protect eyes from the chips of hardened slag.

scratch start technique: A way of striking an arc by dragging the electrode across the workpiece and then lifting the electrode slightly after touching the work.

self-contained gun: A welding gun that feeds filler wire from a spool mounted on the gun and not from a separate wire feeder.

shielding gases: Inert or semi-inert gases commonly used in several welding processes such as GMAW and GTAW to protect the weld area from atmospheric contamination.

slag: A hard crust on the weld created when the flux cools and hardens; it protects the weld deposit from being contaminated from the air, but it must be cleaned to expose the finished weld beneath.

SMAW: The American Welding Society abbreviation for shielded metal arc welding. Better known by its informal name, stick welding.

spark lighters, flint lighters, and torch igniters: Tools used to light welding torches safely.

stickout distance: A term used to describe electrode extension, or the distance from the end of the contact tip to the end of the electrode.

stick welding: See Shielded Metal Arc Welding (SMAW).

stringer bead: A type of weld bead formed by moving the electrode straight across the joint.

tapping technique: A way of lighting the arc in which the electrode is brought straight down to the workpiece and then lifted slightly to start the arc.

temperature indicating crayons: Marking tools used to create marks that melt when the required temperature has been reached.

thermal conductivity: The rate at which heat flows through metal.

weave bead: A weld bead formed by moving the electrode along the joint in a weaving motion.

welder's pliers: A grasping tool that is excellent for picking up just welded metal pieces.

weld symbol: The representation that indicates the welding processes used in welding, i.e., whether the weld is localized or "all around," shop or field, and what its contour is.

welding symbol: The representation of the weld symbol on a blueprint. The assembled welding symbol can consist of reference line, arrow, basic weld symbols, dimensions and other data, supplementary symbols, finish symbols, tail, and specification, process, or other reference.

wire feeder: The device either built inside the welder or set beside the welder that feeds wire to the welding gun.

Pre-Program Discussion Questions

1. What is welding? How many different types of welding processes do you think there are? Name some processes and cite some examples of tasks performed with them.

2. What is an electric arc?

3. What is an electrode and how is it used in welding? What significance does polarity have with electrodes?

4. What is a welding duty cycle? Why is it important?

5. What dangers are present when welding, and what safety gear and equipment provide protection from them? What specific welding tasks might require additional safety precautions?

Post-Program Discussion Questions

1. What is the difference between a ferrous and non-ferrous metal? What are ways to determine what kind of metal a material is?

2. What additional safety precautions must you keep in mind when performing Shielded Metal Arc Welding? What is arc flash? Name TIG-specific safety precautions to consider when welding.

3. What are shielding gases? What are typical shielding gases used in Gas Metal Arc Welding?

4. What are important facts to remember about the electrodes used in Tungsten Inert Gas welding? (Identify at least six facts.)

5. What is stickout distance? What is the proper stickout distance for MIG welding? For TIG welding?

Individual Student Project

Using the library, the Internet, and welding manuals, write a research paper or create a presentation on each of the three main welding processes highlighted in the program. Answer the following questions for each process and include relevant pictures, drawings, charts, or videos, wherever appropriate, to support your findings.

- **GMAW.** What metals can GMAW weld? What can it not weld? What is travel speed and how can it affect your GMAW weld? What is stickout distance and how can it affect your weld? What is meant by electrode orientation and how can it affect your weld? What effect does shielding gas have on a weld? Are some gases better than others? How so? How does an inert gas differ from an active or reactive gas?

- **SMAW.** Look at SMAW from a historical perspective. How did it come into being? What types of current are used and is one type better than another for SMAW welding? Why is that so? What kinds of electrodes are available and which are the most commonly used? How do fast-fill, fast-freeze, and fast-follow electrodes differ from each other? What is slag and how do you remove it? What is arc blow and how can its effects be reduced? What are two ways to strike an arc in SMAW welding? What safety considerations are specific to this type of welding process?

- **GTAW.** How was GTAW first developed? What are the characteristics of each color of electrode? What effect do temperature and travel speed have on welds? (Provide examples.) What function does the collet serve in the torch? What relation does arc length have to arc voltage and electrode diameter?

Group Activities

- Divide into small groups and create charts, posters, and/or presentations that explain the various welding and cutting processes, along with the corresponding metals and thicknesses possible with each process.

- Divide into small groups and create a series of posters that address the following safety topics: general safety, safety gear and equipment, potential health hazards, preventing electric shock, etc. Include photos and safety tips, where appropriate.

- As a class, review the equipment and setup of the various welding processes. Then, in small groups, practice setting up the equipment, and using it to create a wide array of joints and beads. Finally, review and practice how to shut down, store, and maintain each set of equipment.

Internet Activities

- Create a "family tree" poster or presentation of welding processes (such as electric arc welding, wire-feed welding, etc.), using the various welding processes and names as branches. Be sure to include innovations on the horizon for today's (and tomorrow's) welding methods, technologies, or processes. Use relevant photos, graphics, and/or video clips of the processes, wherever possible.

- Using the Internet, research the history of welding processes and methods, and make a timeline of the advent of each process and its main function. Then, choose a kind of welding process not covered in the program and discuss its alternate names and acronyms, main purposes, advantages and disadvantages, and main equipment / components.

- With hundreds of types of welding processes available, it makes sense that a wide variety of welding jobs are possible. Research the Internet and create a presentation that describes the various welding careers present in the U.S. today. Be sure to include not only the most popular jobs but also a few one might overlook as possibilities. Which careers interest you the most, and why?

Assessment Questions

Q1: True or False: With a consumable electrode, 70% of the heat goes to the electrode.

Q2: With a **[positive / negative]** electrode, there is a larger surface area within the arc for the electrons to hit on the workpiece, but with a **[positive / negative]** electrode, there is a smaller area just at the end of electrode, resulting in a deeper penetration in the weld.

Q3: Match each term with its corresponding description.

a) Ferrous b) Non-ferrous c) Consumable d) Non-consumable

e) Weld Symbol f) Welding Symbol g) Scratch Start h) Tapping Start

1) In the _____ technique, the electrode is brought straight down to the workpiece and then lifted slightly to start the arc. In the _____ technique the electrode is dragged across the workpiece and then lifted slightly after touching the work.
2) A _____ indicates the process used in welding, while a _____ is the representation of this on a blueprint.
3) Aluminum is an example of a _____ metal, while iron is a _____ metal.
4) An electrode is _____ if it is used simply to direct the current or _____ if it melts into the weld.

Q4: Which of the following is a magnetic metal? (Select all that apply.)

a) Steel b) Stainless steel c) Alloy chrome moly steel d) Copper

Q5: Which of the following tools would be best for cleaner cuts when cutting metal? (Select all that apply.)

a) Chop saw b) Cutting torch c) Grinder d) Metal-cutting band saw
e) Stick welding machine set on high

Q6: Match each tool with its corresponding description.

a) C-clamps b) Locking pliers c) Magnetic holders d) Tank wrench
e) Valve wrench f) Welder's pliers g) Welding cylinder wrench

1) _____ — excellent for picking up just-welded metal pieces.
2) To make adjustments on welding equipment, use _____, _____, or _____, depending on what you are adjusting.
3) For securing metalwork while welding, reach for _____, _____, and _____.

Q7: If a 150 amp welder has a duty cycle of 30%, what does this signify? (Select the best answer.)

a) It can only be used for 30 minutes before having to be "rested."
b) It must be "rested" for 3 minutes after 3 minutes of continuous welding.
c) It must be "rested" for 3 minutes after 7 minutes of continuous welding.
d) It must be "rested" for 7 minutes after 3 minutes of continuous welding.

Q8: What is the proper stickout distance for the electrode when performing GMAW?

a) 1/8″ – 1/4″
b) 1/4″ – 1/2″
c) 1/4″ – 3/8″
d) 1/4″ – 1″
e) 3/8″ – 1″

Q9: What kinds of shielding gases are used in TIG welding to protect the electrode and weld pool from contaminants? (Select all that apply.)

a) Argon b) Carbon Dioxide c) Helium d) Nitrogen

Q10: **[MIG / TIG]** welding is versatile and simple, and preferred in the maintenance and repair industry; it can be used on various alloys and on rusty or dirty metals without prepping the metal; and it can be performed in any position and under most weather conditions, even drafty areas. **[MIG / TIG]** welding creates superior, clean, and precise welds on nearly all kinds of metals and alloys — even between dissimilar metals; it can be used in all weld positions, even vertically or overhead, so it works well in small, confined areas; it is free of spatter, sparks, and smoke; and it needs very little post-weld cleaning, as no slag needs to be removed between weld passes. **[MIG / TIG]** welding requires a higher level of skill, as the equipment is more complex than other processes; it is sometimes difficult to start the arc; and it poses problems with attempting to weld in drafty areas. **[MIG / TIG]** welding can't be used on metals thinner than 18 gauge (or 1/16 of an inch); the process has a steep learning curve, requires frequent rod changing, and makes lots of splatter, so welds must be cleaned up after they are finished.

Assessment Questions Answer Key

Q1: True or False: With a consumable electrode, 70% of the heat goes to the electrode.
A1: *This statement is false.*

Q2: With a **[positive / negative]** electrode, there is a larger surface area within the arc for the electrons to hit on the workpiece, but with a **[positive / negative]** electrode, there is a smaller area just at the end of electrode, resulting in a deeper penetration in the weld.
A2: *With a **negative** electrode, there is a larger surface area within the arc for the electrons to hit on the workpiece, but with a **positive** electrode, there is a smaller area just at the end of electrode, resulting in a deeper penetration in the weld.*

Q3: Match each term with its corresponding description.

a) Ferrous b) Non-ferrous c) Consumable d) Non-consumable

e) Weld Symbol f) Welding Symbol g) Scratch Start h) Tapping Start

1) In the _____ technique, the electrode is brought straight down to the workpiece and then lifted slightly to start the arc. In the _____ technique the electrode is dragged across the workpiece and then lifted slightly after touching the work.
2) A _____ indicates the process used in welding, while a _____ is the representation of this on a blueprint.
3) Aluminum is an example of a _____ metal, while iron is a _____ metal.
4) An electrode is _____ if it is used simply to direct the current or _____ if it melts into the weld.

A3: *The correct answers are 1 h, g; 2 e, f; 3 b, a; 4 d, c.*

Q4: Which of the following is a magnetic metal? (Select all that apply.)

a) Steel
b) Stainless steel
c) Alloy chrome moly steel
d) Copper

A4: *The correct answer is a (although some stainless steel is magnetic).*

Q5: Which of the following tools would be best for cleaner cuts when cutting metal? (Select all that apply.)

a) Chop saw
b) Cutting torch
c) Grinder
d) Metal-cutting band saw
e) Stick welding machine set on high

A5: *The correct answers are a and d. Power cutting tools — such as a grinder, a cutting torch, or a stick welding machine set on high — tend to leave cuts rough. For cleaner cuts, use a metal-cutting band saw or chop saw.*

Q6: Match each tool with its corresponding description.

a) C-clamps b) Locking pliers c) Magnetic holders d) Tank wrench

e) Valve wrench f) Welder's pliers g) Welding cylinder wrench

1) _____ — excellent for picking up just-welded metal pieces.
2) To make adjustments on welding equipment, use _____, _____, or _____, depending on what you are adjusting.
3) For securing metalwork while welding, reach for _____, _____, and _____.

A6: *The correct answers are 1 f; 2 d, e, g; 3 a, b, c.*

Q7: If a 150 amp welder has a duty cycle of 30%, what does this signify? (Select the best answer.)

a) It can only be used for 30 minutes before having to be "rested."
b) It must be "rested" for 3 minutes after 3 minutes of continuous welding.
c) It must be "rested" for 3 minutes after 7 minutes of continuous welding.
d) It must be "rested" for 7 minutes after 3 minutes of continuous welding.

A7: *The correct answer is d.*

Q8: What is the proper stickout distance for the electrode when performing GMAW?

a) 1/8" – 1/4"
b) 1/4" – 1/2"
c) 1/4" – 3/8"
d) 1/4" – 1"
e) 3/8" – 1"

A8: *The correct answer is c.*

Q9: What kinds of shielding gases are used in TIG welding to protect the electrode and weld pool from contaminants? (Select all that apply.)

a) Argon
b) Carbon Dioxide
c) Helium
d) Nitrogen

A9: *The correct answers are a and c.*

Q10: **[MIG / TIG]** welding is versatile and simple, and preferred in the maintenance and repair industry; it can be used on various alloys and on rusty or dirty metals without prepping the metal; and it can be performed in any position and under most weather conditions, even drafty areas. **[MIG / TIG]** welding creates superior, clean, and precise welds on nearly all kinds of metals and alloys — even between dissimilar metals; it can be used in all weld positions, even vertically or overhead, so it works well in small, confined areas; it is free of spatter, sparks, and smoke; and it needs very little post-weld cleaning, as no slag needs to be removed between weld passes. **[MIG / TIG]** welding requires a higher level of skill, as the equipment is more complex than other processes; it is sometimes difficult to start the arc; and it poses problems with attempting to weld in drafty areas. **[MIG / TIG]** welding can't be used on metals thinner than 18 gauge (or 1/16 of an inch); the process has a steep learning curve, requires frequent rod changing, and makes lots of splatter, so welds must be cleaned up after they are finished.

A10: ***MIG*** *welding is versatile and simple, and preferred in the maintenance and repair industry; it can be used on various alloys and on rusty or dirty metals without prepping the metal; and it can be performed in any position and under most weather conditions, even drafty areas.* ***TIG*** *welding creates superior, clean, and precise welds on nearly all kinds of metals and alloys — even between dissimilar metals; it can be used in all weld positions, even vertically or overhead, so it works well in small, confined areas; it is free of spatter, sparks, and smoke; and it needs very little post-weld cleaning, as no slag needs to be removed between weld passes.* ***TIG*** *welding requires a higher level of skill, as the equipment is more complex than other processes; it is sometimes difficult to start the arc; and it poses problems with attempting to weld in drafty areas.* ***MIG*** *welding can't be used on metals thinner than 18 gauge (or 1/16 of an inch); the process has a steep learning curve, requires frequent rod changing, and makes lots of splatter, so the welds must be cleaned up after they are finished.*

Additional Resources

Associated Builders and Contractors
www.abc.org

American National Standards Institute (ANSI)
www.ansi.org

American Welding Society
www.aws.org

Hobart Institute of Welding Technology
www.welding.org

National Center for Construction Education and Research (NCCER)
www.nccer.org

Occupational Safety & Health Administration (OSHA)
www.osha.gov

Only Weldig
www.onlywelding.com

SkillsUSA
www.skillsusa.org

U.S. Department of Labor, Bureau of Labor Statistics
www.bls.gov

Vocational Information Center
www.khake.com

Additional Resources at www.films.com

Available from Films Media Group • www.films.com • 1-800-257-5126

Introduction to Welding

- **VHS/DVD**
- **Preview clip online**
- **Includes viewable/printable teacher's guide**
- **Correlates to educational standards**
- **Order #25686**

This live-action series introduces viewers to four major welding areas: oxyfuel, shielded metal arc, gas tungsten arc, and gas metal arc/flux core arc welding. Each video features welding definitions, welding components, safety equipment, assembly and use of the system, and the types and kinds of welds. Safety procedures are emphasized throughout, including the proper clothing, equipment, and filter lens required for the job. An excellent overview of the field while clearly demonstrating proper technology in each area. The series includes *Introduction to Gas Metal Arc Welding and Flux Core Welding; Introduction to Gas Tungsten Arc Welding; Introduction to Oxyfuel Welding;* and *Introduction to Shielded Metal Arc Welding.* (11-14 minutes each) © 1998

Safety First: Welding Shop Safety

- **VHS/DVD**
- **Closed captioned**
- **Order #14465**

Specific protective gear for welders is examined in detail. The necessity of having a good attitude and concentrating on the task you are performing are also discussed. Shows the proper way to store tanks, hoses, gauges, and cutting/brazing torches. Also covers the basics of testing lines for leaks, attaching gauges to tanks, and adjusting pressure settings to proper levels. Covers a variety of welding processes including MIG, TIG, and oxyacetylene. The most common concerns of welders are discussed including proper grounding of the machine and the work piece, correct applications of commercial gases, and maintaining weld tips. A Cambridge Educational Production. (30 minutes) © 1995

Auto Body Repair: Welding

- **VHS/DVD**
- **Preview clip online**
- **Closed captioned**
- **Includes viewable/printable teacher's guide**
- **Correlates to educational standards**
- **Order #32777**

This video puts safety first as it explains how to use a MIG (GMAW) welder. Weld types, welder setup, destructive tests, and general welding techniques are covered. The causes of contact burnback, incomplete fusion, and other problems are identified. Correlates to the standards for the Collision Repair and Refinish Technician Training Certification Program, from the National Institute for Automotive Service Excellence and the National Automotive Technicians Education Foundation. (23 minutes) © 2005

Welding

- **VHS/DVD**
- **Preview clip online**
- **Correlates to educational standards**
- **Order #24224**

Welding is part of the series *Vo/Tech: Ins and Outs,* which introduces several occupations in the vocational and technical trades. Each program includes interviews with students preparing for a particular career as well as with working professionals on the job. The programs carefully define how the participant began in the field, what the vocation means to them, educational requirements, immediate job opportunities, and how they envision the future of each particular occupation. (15 minutes) © 2001

Welding Rod Model Bridges

- **VHS/DVD**
- **Includes viewable/printable teacher's guide**
- **Correlates to educational standards**
- **Order #20353**

This video examines the use of welding rods in the construction of model bridges. Starting with an introduction to basic engineering principles, viewers learn about the loads and forces which affect all structures. Key concepts such as live and dead loads, structural failure, and thrust lines are explained in detail, along with an examination of the five forces of compression, tension, shear, torsion, and bending. These principles are then put to the test as students construct model bridges, using a limited amount of materials, which are stress tested in competition. (15 minutes) © 1993

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