



Advanced Welding and Pipe Fitting Grade 12

Unit #1

Course/Subject: Advanced Welding and Pipe fitting	Grade: 12	Welding Fundamentals	Suggested Timeline 4 weeks
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Grade Level Summary	Advanced Metal Engineering combines advanced instruction in Introductory Electric ARC and gas welding with hands-on training in the field of today's world of advanced metal working. This course includes instructions in welding processes including MIG, TIG, and Plasma processes in metal shaping and construction. Pipe fitting will be the second part of this course and will include the use and joining on PVC, steel, copper tubing used today in the Agricultural Industry.
Grade Level Units	Unit 1: Welding Fundamentals Unit 2: Metal Technology Unit 3: Shielded Metal Arc Welding Unit 4: Gas Tungsten, Gas Metal, and Flux Cored Arc Welding Unit 5: Oxyfuel Gas Processes; Metal Technology Unit 6: Plasma Arc Cutting Unit 7: Resistance welding Unit 8: Special Processes Unit 9: Professional Welding

Unit Title	Welding Fundamentals
Unit Summary	In this unit students will look at the safety in the welding industry. The unit will look at shop and personal safety. Also a key aspect of welding is being able to read welding prints, a big portion of this unit revolves around the basics of print reading, different types of joints, symbols and welding positions. Once print reading can be accomplished the unit then looks at all the different types of welding and cutting processes.

Unit Essential Questions: 1. How does keeping safety the number one concern make you a better welder and better working environment?	Key Understandings: 1. Shop safety 2. Welding safety 3. Weld print reading 4. Weld joints 5. Welding positions 6. Different types of welding and cutting processes
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Focus Standards Addressed in the Unit:

Standard Number	Standard Description
PST.01.03.01.a	Compare and contrast the principles and procedures of different welding and cutting processes.

PST.02.02.02.b	Apply safety principles and applicable regulations to operate equipment, machinery and power units used in AFNR power, structural and technical systems.
PST.04.01.01.a	Interpret and explain the meaning of symbols used in sketches of agricultural structures.

Important Standards Addressed in the Unit:

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Misconceptions:	Proper Conceptions:
<ol style="list-style-type: none"> 1. Welding is done by touching an electrical source to metal and they become one. 2. Math and reading skills are not needed to have a welding career. 	<ol style="list-style-type: none"> 1. Most welding is done by creating an electrical arc. The electrode and metal do not actually touch during the welding process. 2. Math is a big component of welding and weld print reading. Diagrams and schematics are how projects are constructed. Reading and measuring are key components to becoming a successful welder.

Knowledge & Concepts	Skills & Competencies	Dispositions & Practices
<ul style="list-style-type: none"> • dangers in an agricultural mechanics shop and work place • safety colors used on signs and icons in the agriculture industry • Proper firefighting equipment. • safety rules and regulations • first aid methods and procedures using supplies in a first aid kit • various types of welding and cutting equipment including oxyacetylene and plasma arc • various joints to include fillet butt joint, vertical tee joint, double bevel joint and fillet tee joint • welding print reading • welding print symbols 	<ul style="list-style-type: none"> • List safety procedures that promote avoidance of shop hazards and accident reduction. • Identify and demonstrate wearing of personal protective equipment • Demonstrate positive safety attitudes and responsibilities • Describe regulations, safety and consumer protection • Read blueprints and schematics for welding • Read work order, instructions, formulas or processing charts • Perform daily safety practices • 	<ul style="list-style-type: none"> • Persistence • Resilience

Academic Vocabulary:

<ul style="list-style-type: none"> • Accident • Personal factors • Physical factors • American Welding Society • Safety in Welding , Cutting, and Allied Processes • Housekeeping • Combustibles • Flame resistance 	<ul style="list-style-type: none"> • Filter shade • High voltage • Air-supplied breathing apparatus • Powered air purifier • Air supplied respirator • Air-purifying respirators • High pressure cylinder • Torch lighter • Fire watch 	<ul style="list-style-type: none"> • Flame retardant • Arc helmet • Leather apron • Leather cape • Cap • Gloves • Safety glasses • Arc ray • Work envelope
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<ul style="list-style-type: none"> • Mechanical drawing • Assembly drawing • Detail drawing • Orthographic projection • Multiview projection • Projection plane • Parallel projection • Front view • Right side view • Left side view • Top view • Bottom view • Back view • Rear view • Pictorials • Pictorial drawings • Axonometric projection • Isometric view • Trimetric view • Diametric view • Section view • Detail view • Field weld symbol • Plug weld • Slot weld • Pitch • Spot weld • Seam weld • Electrode angle • Travel angle • Drag angle • Drag travel angle • Backhand welding • Push angle • Forehand welding • Work angle • Flash welding • Plasma arc cutting • Shielded metal arc cutting • Air carbon arc cutting • Arc stud welding (SW) • Cold welding (CW) • Explosion welding (EXW) • Forge welding (FOW) • Friction welding (FRW) • Friction stir welding (FSW) 	<ul style="list-style-type: none"> • Object lines • Hidden edge lines • Center lines • Dimension line • Cutting plane line • Section line • Extension lines • Leader lines • Full scale • Drawn to scale • Half scale • Weld joint • Butt joint • Edge preparation • Groove weld • Groove joint • Groove face • Groove angle • Bevel angle • Weld root • Root face • Weld face • Lap joint • Corner joint • T-joint • Edge joint • Flange joint • Flare-groove joint • Welding temperature • Filler material • Shielded metal arc welding • Base metal • Alternating current (AC) • Direct current (DC) • Gas Tungsten Arc welding • Tungsten inert gas (TIG) • Ultrasonic welding (USW) • Laser beam welding (LBW) • Electric beam welding (EBW) • Torch plastic welding 	<ul style="list-style-type: none"> • Kill switch • Fillet welds • Stringer bead • Weave bead • Joint geometry • Tack weld • Penetration • Welding position • Weld axis • Overhead welding • American National Standards Institute (ANSI) • American Welding Society (AWS) • Weld symbol • Reference line • Arrow side • Other side • Root opening • Finish symbol • Intermittent welding • Length dimension • Pitch dimension • Chain intermittent weld • Staggered intermittent welds • Weld-all-around symbol • Stringer bead • Cover pass • Gas metal arc welding • Metal inert gas (MIG) • Flux cored arc welding (FCAW) • Oxyacetylene welding • Torch soldering • Oxidizing flame • Torch brazing • Oxyfuel gas cutting (OFC) • Oxyfuel gas under water cutting • Oxygen Arc cutting • Oxygen lance cutting • Exothermic cutting • Flux cutting • Metal powder cutting • Resistance spot welding • Projection welding • Resistance seam welding (RSEW)
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Assessments:

- Test
- Quizzes
- Daily logs
- Projects
- Safety checks
- Participation

Differentiation:

- Book work
 - Lecture
 - Demonstrations
 - Video clips
 - Hands on learning
 - IEP accommodations
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Interdisciplinary Connections:

- This unit covers many aspects of safety in an industrial setting which can be used in every day situation. Students will learn safe practices to handle flammable substances and protective gear against fire. Information like this can be used in classes such as chemistry where they may use chemicals and flames. Another large portion of this Unit is related to math and in particular Geometry. The part of this unit that speaks about weld prints and weld angles is highly relatable to geometry in the use of angles and shapes. This part of the unit can also be related to Technology Education and the technical drawing courses.
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Additional Resources:

- Video clips
 - Articles
 - Personal Accounts
 - Modern Welding textbook
 - Welding Technology Fundamentals textbook
 - Agricultural Technology and Mechanics textbook
 - Math for welders textbook
 - Welding print reading textbook
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Created By:

Troy Summey



Advanced Welding and Pipe Fitting Grade 12

Unit #2

Course/Subject: Advanced Welding and Pipe fitting	Grade: 12	Metal Technology	Suggested Timeline: 3 weeks
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Grade Level Summary	Advanced Metal Engineering combines advanced instruction in Introductory Electric ARC and gas welding with hands-on training in the field of today's world of advanced metal working. This course includes instructions in welding processes including MIG, TIG, and Plasma processes in metal shaping and construction. Pipe fitting will be the second part of this course and will include the use and joining on PVC, steel, copper tubing used today in the Agricultural Industry.
Grade Level Units	Unit 1: Welding Fundamentals Unit 2: Metal Technology Unit 3: Shielded Metal Arc Welding Unit 4: Gas Tungsten, Gas Metal, and Flux Cored Arc Welding Unit 5: Oxyfuel Gas Processes; Metal Technology Unit 6: Plasma Arc Cutting Unit 7: Resistance welding Unit 8: Special Processes Unit 9: Professional Welding

Unit Title	Metal Technology
Unit Summary	This unit looks at the process of making different metals and how they are shaped. Along with how they are made the unit looks at the different properties that each metal has from the process it has gone through. Finally, in the unit we learn how to heat treat different metals and what the heat treatment does for metal.

Unit Essential Questions: 1. What characteristics do you use to determine a type of metal?	Key Understandings: 1. Production of metals 2. Identifying metals 3. Metal properties 4. Heat treating metal
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Focus Standards Addressed in the Unit:

<i>Standard Number</i>	<i>Standard Description</i>
PST.01.03.02.a	Compare and contrast the properties of different metals used in AFNR power, structural and technical systems.

Important Standards Addressed in the Unit:

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Misconceptions:	Proper Conceptions:
<ol style="list-style-type: none"> 1. All steel is the same. 2. All metal is “hard”. 	<ol style="list-style-type: none"> 1. Steel comes with different carbon contents that contribute to different properties and strengths. 2. Hardness is created through a heat treatment process that actually make the metal more brittle.

Knowledge & Concepts	Skills & Competencies	Dispositions & Practices
<ul style="list-style-type: none"> • Heat treatment process • Ferrous metals • Nonferrous metals • Production of metals • Shaping of metal • Metal properties 	<ul style="list-style-type: none"> • Identify and select various types of metals. • Differentiate between ferrous and nonferrous • Identify and select metal by shape • Treat metal for desired properties 	<ul style="list-style-type: none"> • Curiosity

Academic Vocabulary:		
<ul style="list-style-type: none"> • Alloy steels • Straight carbon steel • Plain carbon steel • Hot iron • Pig iron • Steelmaking furnace • Flux • Blast furnace • Hopper • Tuyere • Basic oxygen furnace • Ladle • Heat • Open hearth furnace • Vacuum furnace • Vacuum streaming • Ladle degassing • Vacuum induction furnace • Vacuum arc furnace • Electroslag remelting process • Continuous casting process • Tundish • Ingot • Soaking pit • Billet • Decarburization • Grey cast iron • White cast iron 	<ul style="list-style-type: none"> • Nonferrous metal • Ferrous metal • Carbon steel • Alloy steel • Physical property • Compression strength • Hardness • Elongation • Brittleness • Toughness • Ductility • Simple alloy • Body-centered cubic structure • Hexagonal close-packed structure • Iron-carbon diagram • Ferrite • Critical temperature • Cementite • Pearlite • Austenite • Eutectoid point • Hypoeutectoid steels • Hypereutectoid steels • Eutectic point • Hypoeutectic cast iron • Liquidus line • Solidus line • Oxyacetylene torch test 	<ul style="list-style-type: none"> • Preheating • Interpass heating • Postweld heat treatment • Temperature gradient • Heat-affected zone (HAZ) • Critical temperature • Electrical resistance heating • Induction heating • Furnace • Upper transformation temperature • Time-temperature-transformation (T-T-T) • Annealing • Grain-refined region • Grain-coursed region • Elastic limit • Yield strength • Process anneal • Normalizing • Thermal stress relieving • Spheroidizing • Surface hardening • Flame hardening • Casehardening • Ductile cast iron Hall process • Distilling process • Rolling mill • Forging

<ul style="list-style-type: none"> • Cupola furnace • Tapping • Crucible • Electrolysis • Cathodes • Electrolyte • Alloy brass • Alloy bronze • Charge 	<ul style="list-style-type: none"> • Color test • Density • Specific gravity test • Magnet test • Chip test • Society of Automotive Engineers (SAE) • Deoxidized copper • Hot shortness 	<ul style="list-style-type: none"> • Extrusion • Drawing • Powdered metal
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Assessments:

- Test
 - Quizzes
 - Daily logs
 - Projects
 - Safety checks
 - Participation
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Differentiation:

- Book work
 - Lecture
 - Demonstrations
 - Video clips
 - Hands on learning
 - IEP accommodations
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Interdisciplinary Connections:

- This unit relates very well to science courses when the metal is taking on different physical properties. Also in the creation of many of the metals and alloys. Elements and chemicals reactions are being combined to create many alloys.
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Additional Resources:

- Video clips
 - Articles
 - Personal Accounts
 - Modern Welding textbook
 - Welding Technology Fundamentals textbook
 - Agricultural Technology and Mechanics textbook
 - Math for welders textbook
 - Welding print reading textbook
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Advanced Welding and Pipe Fitting Grade 12

Unit #3

Course/Subject:
Advanced Welding and Pipe fitting

Grade:
12

Shielded Metal Arc Welding

Suggested Timeline:
4-5 weeks

Grade Level Summary	Advanced Metal Engineering combines advanced instruction in Introductory Electric ARC and gas welding with hands-on training in the field of today's world of advanced metal working. This course includes instructions in welding processes including MIG, TIG, and Plasma processes in metal shaping and construction. Pipe fitting will be the second part of this course and will include the use and joining on PVC, steel, copper tubing used today in the Agricultural Industry.
Grade Level Units	Unit 1: Welding Fundamentals Unit 2: Metal Technology Unit 3: Shielded Metal Arc Welding Unit 4: Gas Tungsten, Gas Metal, and Flux Cored Arc Welding Unit 5: Oxyfuel Gas Processes; Metal Technology Unit 6: Plasma Arc Cutting Unit 7: Resistance welding Unit 8: Special Processes Unit 9: Professional Welding

Unit Title	Shielded Metal Arc Welding
Unit Summary	This unit looks into the equipment and supplies needed to weld with a shielded arc welder. Technique and safety are also aspects of this unit that will be looked while students practice their skills of arc welding.

Unit Essential Questions: 1. What are the different types of arc welding and how do they differ and work?	Key Understandings: 1. Arc welding supplies 2. Arc welding equipment 3. Arc welding safety 4. How the arc welding system works 5. How to weld using the arc welder (starting, running a bead) 6. Weld defects
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Focus Standards Addressed in the Unit:

<i>Standard Number</i>	<i>Standard Description</i>
PST.01.03.02.b	Assess and select the proper electrode for use in various shielded metal arc welding situations.
PST.01.03.01.c	Evaluate the quality of metal fabrication procedures.

PST.01.03.02.c	Construct and/or repair metal structures and equipment using metal fabrication procedures.
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Important Standards Addressed in the Unit:

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Misconceptions:	Proper Conceptions:
1. There is no serious issue while welding	1. Welding can be dangerous and even fatal if not done correctly. Electrocution can occur if the electrode and ground are connected.

Knowledge & Concepts	Skills & Competencies	Dispositions & Practices
<ul style="list-style-type: none"> • safety rules and regulations. • various joints to include fillet butt joint, vertical tee joint, double bevel joint and fillet tee joint • various types of welders (AC, DC, CC) • Methods to create an arc • Various metals and classifications • Ohm's law and the flow of electricity • Hand tools, personal safety equipment, and clothing for welding task • Basic welding joints • Basic welding position • Welding defects 	<ul style="list-style-type: none"> • Identify and demonstrate wearing of personal protective equipment. • Identify and use proper firefighting equipment • Demonstrate positive safety attitudes and responsibilities • Identify and select various types of welding and cutting equipment including oxyacetylene and plasma arc • Identify and weld various joints to include fillet butt joint, vertical tee joint, double bevel joint and fillet tee joint. • Fabricate a product by hand. • Determine correct shade of welding lens • Complete a safety inspection of arc welding station • Select correct electrode, current and polarity for welding • Strike a welding arc and produce acceptable stringer and weaving beads • Restart arc and blend new and old beads • Weld all 5 basic welds in all positions • Identify welding defects • Pass safety test related to arc welding areas 	<ul style="list-style-type: none"> • Persistence

Academic Vocabulary:

<ul style="list-style-type: none"> • Shielded metal arc welding (SMAW) • Inverter • Static volt ampere curve 	<ul style="list-style-type: none"> • Tapped secondary winding • Saturable reactor • Magnetic amplifier control • Generator 	<ul style="list-style-type: none"> • Carbon and low alloy steel electrode classification number • Tensile strength • Suffix
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<ul style="list-style-type: none"> • Output slope • Constant current machine • Droop curve machines • Drooper • Primary winding • Primary coil • Reducer • Step-down transformer • Secondary winding • Secondary coil • Laminated iron core • Solid-state devices • Diode • Silicon-controlled rectifiers • Transistor • Movable shunt transformer control • Movable core reactor • Inductive reactance • Backstep method • Contoured • Undercut • Flat welding • Horizontal welding • Vertical welding • Overhead welding 	<ul style="list-style-type: none"> • Alternation current • Constant current transformer-rectifier • Armature coil winding • Brushes • Field windings • Exciter • Direct current electrode negative • Direct current electrode positive • Inverter switcher • Dual source with inverter switching • Rated output current rating • Rated load voltage • Welding voltage • Electrical power input requirements • Lugs • Connectors • Neutral gasses • Slag • Drag electrodes • Porosity • Root pass • Whipping motion • 	<ul style="list-style-type: none"> • Low-hydrogen electrodes • Copper-based electrodes • Nickel-based electrode • Chipping hammer • Arc flame • Vaporized metal • Liquid metal • Polarity • Metal composition • Welding position • Arc length • Spattering • Stringer bead • Weave bead • Weld reinforcement • Hard surfacing • Run-off tab • Slag inclusion • Forward arc blow • Backward arc blow
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Assessments:

- Test
 - Quizzes
 - Daily logs
 - Projects
 - Safety checks
 - Participation
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Differentiation:

- Book work
 - Lecture
 - Demonstrations
 - Video clips
 - Hands on learning
 - IEP accommodations
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Interdisciplinary Connections:

- This unit has interdisciplinary connections in the ability to problem solve and critical thinking. Student must decide what type of metal they are working with and then determine how to set up the machine to match. In doing so they must pull from past information. When they actually are performing the task of welding, hand eye coordination is a skill they must master in order to create good welds that are structurally sound.
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Additional Resources:

- Video clips
 - Articles
 - Personal Accounts
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- Modern Welding textbook
 - Welding Technology Fundamentals textbook
 - Agricultural Technology and Mechanics textbook
 - Math for welders textbook
 - Welding print reading textbook
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Advanced Welding and Pipe Fitting Grade 12

Unit #4

Course/Subject:
Advanced Welding and Pipe fitting

Grade:
12

Gas Tungsten, gas metal, and flux core arc welding

Suggested Timeline:
6 weeks

Grade Level Summary	Advanced Metal Engineering combines advanced instruction in Introductory Electric ARC and gas welding with hands-on training in the field of today's world of advanced metal working. This course includes instructions in welding processes including MIG, TIG, and Plasma processes in metal shaping and construction. Pipe fitting will be the second part of this course and will include the use and joining on PVC, steel, copper tubing used today in the Agricultural Industry.
Grade Level Units	Unit 1: Welding Fundamentals Unit 2: Metal Technology Unit 3: Shielded Metal Arc Welding Unit 4: Gas Tungsten, Gas Metal, and Flux Cored Arc Welding Unit 5: Oxyfuel Gas Processes; Metal Technology Unit 6: Plasma Arc Cutting Unit 7: Resistance welding Unit 8: Special Processes Unit 9: Professional Welding

Unit Title	Gas Tungsten, gas metal, and flux core arc welding
Unit Summary	In this unit students will examine the other types of arc welding there including MIG, TIG, and Flux core welding. Welders that use gas as a flux and a continuous flow of metal instead of the traditional stick arc welder. Students will learn the set up and proper welding techniques using the MIG, TIG, and Flux core welders.

Unit Essential Questions: 1. Why are MIG and TIG welders used for finish welding?	Key Understandings: 1. Gas tungsten welding (TIG) 2. Flux core welding 3. Gas metal arc welding (MIG) 4. Welding techniques 5. Welder set up 6. Welder maintenance
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Focus Standards Addressed in the Unit:

Standard Number	Standard Description
PST.02.02.02.c	Adjust equipment, machinery and power units for safe and efficient operation of AFNR power, structural and technical systems.

PST.02.02.02.a	Examine and identify safety hazards associated with equipment, machinery and power units used in AFNR power, structural, and technical systems.
PST.02.02.02.b	Apply safety principles and applicable regulations to operate equipment, machinery and power units used in AFNR power, structural and technical systems.

Important Standards Addressed in the Unit:

Misconceptions:

1. MIG and TIG welding does not have flux.

Proper Conceptions:

1. MIG and TIG welding both use a gas flux to clean the weld.
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Knowledge & Concepts	Skills & Competencies	Dispositions & Practices
<ul style="list-style-type: none"> • Function of GTAW, GMAW, and FCAW • Various types of shielding gases used in GMAW, GTAW, and FCAW • Assemble the parts of GTAW welding station and GTAW torch • Metal preparation for welding • Self shielded and gas shielded methods of FCAW • Weld joints • Weld positions 	<ul style="list-style-type: none"> • Identify and specify the type of electrode used for GMAW • Identify and specify the various electrode wires used in GMAW and FCAW • Correctly set and adjust the welding current and shielding gas flow rate • Weld different base metals using GTAW, GMAW, and FCAW processes • Identify potential safety hazards • Pass safety test on proper and safe use of GTAW, GMAW, and FCAW processes • Select the proper arc welding machine, wire feeder, shielding gas, flow rate, contract tube, nozzle size, and welding wire type to produce an acceptable weld. • Identify and demonstrate wearing of personal protective equipment • Identify and select various types of metals • Identify and weld various joints to include fillet butt joint, vertical tee joint, double bevel joint and fillet • Fabricate a product by hand. • 	<ul style="list-style-type: none"> • Persistence

Academic Vocabulary:

<ul style="list-style-type: none"> • Gas Tungsten arc welding (GTAW) • Gas metal arc welding (GMAW) 	<ul style="list-style-type: none"> • Semiautomatic welding • Peak current 	<ul style="list-style-type: none"> • Self-shielded flux cored welding (FCAW-S)
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<ul style="list-style-type: none"> • Flux core arc welding (FCAW) • Constant current • Rectified • Balanced wave • Unbalanced wave • Reinitiate • Sinusoidal wave • Porosity • Collet body • Gas lens • Turbulent stream • Bird's nest • Inert gas • Reactive gases • Electrode extension 	<ul style="list-style-type: none"> • Background current • Sine wave • Upslope current • Downslope current • Preflow • Postflow • Peak time • Exit diameters • Hot shortness • Touch start • Superimposed high frequency • High-voltage start • Keyhole • Inductance • Wire feeder 	<ul style="list-style-type: none"> • Gas Shielded flux cored arc welding (FCAW-S) • Inch switch • Jog switch • Purge switch • Liner • Self-contained wire feeder • Contact tube • Contact tip • Deoxidizers • Denitrifiers • Dash number
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Assessments:

- Test
 - Quizzes
 - Daily logs
 - Projects
 - Safety checks
 - Participation
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Differentiation:

- Book work
 - Lecture
 - Demonstrations
 - Video clips
 - Hands on learning
 - IEP accommodations
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Interdisciplinary Connections:

- This unit has connections with science. The use of air elements such as Argon, helium, nitrogen etc are found in chemistry class. Students will use these elements while welding.
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Additional Resources:

- Video clips
 - Articles
 - Personal Accounts
 - Modern Welding textbook
 - Welding Technology Fundamentals textbook
 - Agricultural Technology and Mechanics textbook
 - Math for welders textbook
 - Welding print reading textbook
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Advanced Welding and Pipe Fitting Grade 12

Unit #5

Course/Subject: Advanced Welding and Pipe fitting	Grade: 12	Oxyfuel Gas Processes	Suggested Timeline: 5 weeks
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Grade Level Summary	Advanced Metal Engineering combines advanced instruction in Introductory Electric ARC and gas welding with hands-on training in the field of today's world of advanced metal working. This course includes instructions in welding processes including MIG, TIG, and Plasma processes in metal shaping and construction. Pipe fitting will be the second part of this course and will include the use and joining on PVC, steel, copper tubing used today in the Agricultural Industry.
Grade Level Units	Unit 1: Welding Fundamentals Unit 2: Metal Technology Unit 3: Shielded Metal Arc Welding Unit 4: Gas Tungsten, Gas Metal, and Flux Cored Arc Welding Unit 5: Oxyfuel Gas Processes; Metal Technology Unit 6: Plasma Arc Cutting Unit 7: Resistance welding Unit 8: Special Processes Unit 9: Professional Welding

Unit Title	Oxyfuel Gas Processes
Unit Summary	This unit looks at welding using an oxygen and acetylene set up. Flame is produced by the gasses to make a flame hot enough to melt steel. Using the oxyfuel gas welding process metals can be fused together, bond with additive metals, and cut apart. Other processes that will be examined in this unit are soldering and brazing.

Unit Essential Questions: 1. What are possible set ups and uses for an oxyfuel torch?	Key Understandings: 1. Oxyfuel gas welding equipment and supplies 2. Oxyfuel gas welding 3. Oxyfuel gas cutting equipment and supplies 4. Oxyfuel gas cutting 5. Soldering 6. Brazing and braze welding
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Focus Standards Addressed in the Unit:

<i>Standard Number</i>	<i>Standard Description</i>
PST.01.03.01.a	Compare and contrast the principles and procedures of different welding and cutting processes.
PST.01.03.01.c	Evaluate the quality of metal fabrication procedures.

Important Standards Addressed in the Unit:**PST.01.03.02.b**

Analyze the situation and determine the best welding and cutting process to be used in metal fabrication.

Misconceptions:

1. Oxyacetylene is one gas.

Proper Conceptions:

1. Oxyacetylene setup is made up of 2 gasses, oxygen and acetylene. Acetylene is the combustible gas and oxygen is the accelerant to make the flame hotter.

Knowledge & Concepts	Skills & Competencies	Dispositions & Practices
<ul style="list-style-type: none">• Identify and use proper firefighting equipment• positive safety attitudes and responsibilities• various gauges and testers used in agricultural power equipment• various types of welding and cutting equipment including oxyacetylene and plasma arc• soldering process• brazing process• oxyfuel cutting and welding	<ul style="list-style-type: none">• Demonstrate safety rules and regulations.• Describe regulations, safety and consumer protection.• Select, adjust, operate and maintain oxy-fuel equipment with and without filler rods.• Identify and weld various joints to include fillet butt joint, vertical tee joint, double bevel joint and fillet tee• Use soldering equipment.• Repair sheet metal products.• Fabricate a product by hand.• Cut, assemble and pressure test components within various types of water supply systems	<ul style="list-style-type: none">• Curiosity• Persistence

Academic Vocabulary:

<ul style="list-style-type: none">• Oxyfuel gas welding outfit• Oxyfuel gas welding station• Gas supplies• Regulators• Hoses• Welding torch• Welding goggles• Spark lighter• Dewar flasks• Cylinder cap• Valve• Oxygen line regulator• Master regulator• Annealed• Backfire• Work angle• Drag angle	<ul style="list-style-type: none">• Waterseal flashback arrestor• Acetylene regulator• Pressure regulator• High pressure gauge• Low pressure gauge• Bourdon tube• Inside diameter• Cutting torch• Mixing chamber• Throttle• Orifice• Welding tip• Broach• Filter lense• Cover lense• Bellmouthed orifice• Electric motor-driven carriage	<ul style="list-style-type: none">• Economizer• Liquefied petroleum• Oxyhydrogen• Natural gas• Check valve• Flashback arrestor• Refractory• Brazing• Soldering• Oxyacetylene• Oxyhydrogen• Oxynatural gas• Oxypropane• Oxidizing flame• Carburizing flame• Positive pressure torch• Injector-type torch
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<ul style="list-style-type: none"> • Push angle • Eye of the weld pool • Convex • Plug weld • Undercut • Surface tension • Crowned • Kerf • Infrared soldering • Induction soldering • Reaction fluxes • Hydrostatically • Chemical cleaning • Pickling solution • Mechanical cleaning 	<ul style="list-style-type: none"> • Stack cutting • Ignition temperature • Cutting outfit • Cutting oxygen lever • Oxygen jet • Drag • Refractory oxides • Oscillating • Pierce • Automatic cutting • Semiautomatic cutting • Adhesion • Brass • Bronze 	<ul style="list-style-type: none"> • Servomotors • Vernier gear mechanism • Solder • Capillary action • Solidus • Organic fluxes • Inorganic fluxes • Rosin-based fluxes • Degreasing solvent • Pickling • Tinning • Sweating • Solvent • Melting temperature • Flow temperature • Galvanic corrosion
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Assessments:

- Test
 - Quizzes
 - Daily logs
 - Projects
 - Safety checks
 - Participation
-

Differentiation:

- Book work
 - Lecture
 - Demonstrations
 - Video clips
 - Hands on learning
 - IEP accommodations
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Interdisciplinary Connections:

- This unit has connections to science in that there are many natural elements being used. Gas such as oxygen and acetylene are used to produce the flame needed to weld and cut with. Also the metal being used to bond metals together is bronze when brazing.
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Additional Resources:

- Video clips
 - Articles
 - Personal Accounts
 - Modern Welding textbook
 - Welding Technology Fundamentals textbook
 - Agricultural Technology and Mechanics textbook
 - Math for welders textbook
 - Welding print reading textbook
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**Advanced Welding and
Pipe Fitting
Grade 12**

Unit #6

Course/Subject: Advanced Welding and Pipe fitting	Grade: 12	Plasma Arc Cutting	Suggested Timeline: 2 weeks
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Grade Level Summary	Advanced Metal Engineering combines advanced instruction in Introductory Electric ARC and gas welding with hands-on training in the field of today's world of advanced metal working. This course includes instructions in welding processes including MIG, TIG, and Plasma processes in metal shaping and construction. Pipe fitting will be the second part of this course and will include the use and joining on PVC, steel, copper tubing used today in the Agricultural Industry.
Grade Level Units	Unit 1: Welding Fundamentals Unit 2: Metal Technology Unit 3: Shielded Metal Arc Welding Unit 4: Gas Tungsten, Gas Metal, and Flux Cored Arc Welding Unit 5: Oxyfuel Gas Processes; Metal Technology Unit 6: Plasma Arc Cutting Unit 7: Resistance welding Unit 8: Special Processes Unit 9: Professional Welding

Unit Title	Plasma Arc Cutting
Unit Summary	This unit examines the plasma arc cutting process and machines. The unit will look at cutting possibilities and how the system works.

Unit Essential Questions:

1. Why is it called a plasma cutter when no plasma is used?
Explain the process.

Key Understandings:

1. Plasma cutter equipment
2. Plasma machine set up
3. Cutting
4. Safety equipment

Focus Standards Addressed in the Unit:

Standard Number	Standard Description
PST.02.02.02.c	Adjust equipment, machinery and power units for safe and efficient operation in AFNR power, structural and technical systems.
PST.01.03.01.b	Analyze the situation and determine the best welding and cutting process to be used in metal fabrication.

Important Standards Addressed in the Unit:

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Misconceptions:	Proper Conceptions:
1. Plasma cutter uses plasma.	1. Plasma cutters use electricity and high pressure air to cut through metal.

Knowledge & Concepts	Skills & Competencies	Dispositions & Practices
<ul style="list-style-type: none"> various types of welding and cutting equipment including oxyacetylene and plasma arc Equipment required to cut with PAC Assemble and set up PAC equipment Safety equipment required when PAC 	<ul style="list-style-type: none"> Conduct training in product use. Demonstrate proper and safe use of air operated equipment. Identify and select various types of metals. Perform acceptable cut using the PAC process Recognize PAC safety and fire hazards 	<ul style="list-style-type: none"> Curiosity

Academic Vocabulary:		
<ul style="list-style-type: none"> Plasma arc cutting Constricting nozzle Plasma gas Shielding gas 	<ul style="list-style-type: none"> Transferred arc Pilot arc Nontransferred Dross 	<ul style="list-style-type: none"> Dual flow plasma arc cutting Hertz Swirl ring Heat shield

Assessments:
<ul style="list-style-type: none"> Test Quizzes Daily logs Projects Safety checks Participation

Differentiation:
<ul style="list-style-type: none"> Book work Lecture Demonstrations Video clips Hands on learning IEP accommodations

Interdisciplinary Connections:

- This unit has connections to science in the use of electrical circuits. Hand eye coordination is an important element in this unit in order to make a good cut.

Additional Resources:

- Video clips
- Articles
- Personal Accounts
- Modern Welding textbook
- Welding Technology Fundamentals textbook
- Agricultural Technology and Mechanics textbook
- Math for welders textbook
- Welding print reading textbook

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Troy Summey



Advanced Welding and Pipe Fitting Grade 12

Unit #7

Course/Subject: Advanced Welding and Pipe fitting	Grade: 12	Resistance Welding	Suggested Timeline: 3 weeks
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Grade Level Summary	Advanced Metal Engineering combines advanced instruction in Introductory Electric ARC and gas welding with hands-on training in the field of today's world of advanced metal working. This course includes instructions in welding processes including MIG, TIG, and Plasma processes in metal shaping and construction. Pipe fitting will be the second part of this course and will include the use and joining on PVC, steel, copper tubing used today in the Agricultural Industry.
Grade Level Units	Unit 1: Welding Fundamentals Unit 2: Metal Technology Unit 3: Shielded Metal Arc Welding Unit 4: Gas Tungsten, Gas Metal, and Flux Cored Arc Welding Unit 5: Oxyfuel Gas Processes; Metal Technology Unit 6: Plasma Arc Cutting Unit 7: Resistance welding Unit 8: Special Processes Unit 9: Professional Welding

Unit Title	Resistance Welding
Unit Summary	In this unit students will look at a different style of welding that does not use filler metals. Resistance is a type of welding that actually makes contact with the metals being welded and electricity is used to produce heat through resistance causing the metals to melt and bond.

Unit Essential Questions: 1. When would resistance welding be the weld of choice? Why?	Key Understandings: 1. Resistance welding equipment and supplies 2. Resistance welding 3. Resistance welding techniques
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Focus Standards Addressed in the Unit:

<i>Standard Number</i>	<i>Standard Description</i>
PST.01.03.01.a	Compare and contrast the principles and procedures of different welding and cutting processes.
PST.01.03.01.b	Analyze the situation and determine the best welding and cutting process to be used in metal fabrication.
PST.01.03.02.c	Construct and/or repair metal structures and equipment using metal fabrication procedures.

Important Standards Addressed in the Unit:**Misconceptions:**

1. Resistance welding is like other welding such as arc, MIG, TIG where new metal is added to the weld and a bead is formed.

Proper Conceptions:

1. Resistance welding actually touches the metal and pinches the two together until a heat transfer is produced and bonds the two together, leaving a small blush on the metal.

Knowledge & Concepts	Skills & Competencies	Dispositions & Practices
<ul style="list-style-type: none">• Various types of resistance welding machines (spot, seam, projection, upset, and flash-type)• Parts of resistance welding machines• Safety hazards involved with resistance welding• Set up of resistance welder• Identify contact tips purposes• methods of changing appropriate technology for various applications	<ul style="list-style-type: none">• Describe how welding current is induced in the transformer of a resistance welding machine• Name and describe the variables involved in resistance welding.• Select, inspect, and change spot welding electrode• Produce an acceptable resistance weld• Select the contact tip, diameter, current, weld size, electrode force, and weld time.• Visually and destructively test a spot weld to determine its quality• Measure tap setting, percent heat, horn spacing, throat size, and contact tip diameter• List safety procedures that promote avoidance of shop hazards and accident reduction• Identify and select various types of welding and cutting equipment including oxyacetylene and plasma arc• Repair sheet metal products.• Select, measure, use and calibrate testing devices and the machines	<ul style="list-style-type: none">• Curiosity• Persistence

Academic Vocabulary:

<ul style="list-style-type: none">• Resistance welding• Primary voltage• Primary current• Secondary voltage• Secondary current• Primary winding• Secondary winding• Laminated core• Duty cycle• Transgun	<ul style="list-style-type: none">• KVA rating• Squeeze time• Weld time• Hold time• Off time• Trans ratio• Upslope• Downslope• Ignitron tubes• Step-down transformer	<ul style="list-style-type: none">• Electrode face• Electrode diameter• Conductivity• Throat depth• Horn spacing• Three phase resistance spot welding machine• Stored energy spot welding machine• Reactance
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<ul style="list-style-type: none"> • Platen • Flashing • Cross-wire resistance welding • Parallel gap resistance welding • Weld peel • Expulsion weld • Blow hole • Forge force • Flash welding 	<ul style="list-style-type: none"> • Spot welding • Spot weld • Weld nugget • Weld sequence • Weld schedule • Tap setting • Projection welding • Continuous current 	<ul style="list-style-type: none"> • Electrostatic resistance spot welding machine • PSW guns • Gun welding machines • Gun welders • Force gauge • Current analyzer • Intermittent current • Butt seam welding
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Assessments:

- Test
 - Quizzes
 - Daily logs
 - Projects
 - Safety checks
 - Participation
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Differentiation:

- Book work
 - Lecture
 - Demonstrations
 - Video clips
 - Hands on learning
 - IEP accommodations
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Interdisciplinary Connections:

- The interdisciplinary connections in this unit relate to science in that the unit covers many electrical properties. Resistance welding has a lot to do with heat transfer and electricity.
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Additional Resources:

- Video clips
 - Articles
 - Personal Accounts
 - Modern Welding textbook
 - Welding Technology Fundamentals textbook
 - Agricultural Technology and Mechanics textbook
 - Math for welders textbook
 - Welding print reading textbook
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Advanced Welding and Pipe Fitting Grade 12

Unit #8

Course/Subject: Advanced Welding and Pipe fitting	Grade: 12	Special Processes	Suggested Timeline: 6-8
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Grade Level Summary	Advanced Metal Engineering combines advanced instruction in Introductory Electric ARC and gas welding with hands-on training in the field of today's world of advanced metal working. This course includes instructions in welding processes including MIG, TIG, and Plasma processes in metal shaping and construction. Pipe fitting will be the second part of this course and will include the use and joining on PVC, steel, copper tubing used today in the Agricultural Industry.
Grade Level Units	Unit 1: Welding Fundamentals Unit 2: Metal Technology Unit 3: Shielded Metal Arc Welding Unit 4: Gas Tungsten, Gas Metal, and Flux Cored Arc Welding Unit 5: Oxyfuel Gas Processes; Metal Technology Unit 6: Plasma Arc Cutting Unit 7: Resistance welding Unit 8: Special Processes Unit 9: Professional Welding

Unit Title	Special processes
Unit Summary	This unit looks at welding processes that require special equipment and techniques. It looks at combining ferrous and non ferrous metals together. This unit looks into welding techniques in industry like CNC and underwater welding. Other processes in this unit that are covered are pipe welding and fitting along with techniques to change the surface of metals.

Unit Essential Questions: <ol style="list-style-type: none"> 1. Why would ferrous and non ferrous metals need to be welded together? 2. Think of the jobs in underwater welding and pipe welding/fitting, are they specialized jobs? Would they pay well? Where would the jobs be? 	Key Understandings: <ol style="list-style-type: none"> 1. Special welding processes 2. Special ferrous Welding applications 3. Special non ferrous welding applications 4. Pipe and tube welding 5. Special cutting processes 6. Underwater welding and cutting 7. Automatic and robotic welding 8. Metal surfacing
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Focus Standards Addressed in the Unit:

Standard Number	Standard Description
PST.01.03.01.a	Compare and contrast the principles and procedures of different welding and cutting processes.

PST.01.03.02.a	Compare and contrast the properties of different metals used in AFNR power, structural and technical systems.
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Important Standards Addressed in the Unit:

PST.05.01.01.a	Research and categorize computer technologies used to solve problems and increase efficiency in AFNR systems.
PST.05.03.02.a	Examine and summarize the specific intent of technologies used to solve problems and increase the efficiency of AFNR systems.

Misconceptions:	Proper Conceptions:

Knowledge & Concepts	Skills & Competencies	Dispositions & Practices
<ul style="list-style-type: none"> • emerging technologies and their potential impact • Solid state welding • Alloying elements • Heat treatment processes • Welding stainless steel, tool steel, and cast iron • Stainless steel groups • Cast iron groups • Nonferrous metals and alloy • Weld nonferrous metals • Variety of pipe and tube fixture tools • Consumable inserts, backing rings, and backing tape • Nondestructive evaluation methods for pipe • Metal cutting processes other than oxyfuel gas and plasma arc • Exothermic burning and cutting rods • Water jet cutting process • Underwater welding and cutting • Automatic and Robotic welding • Parts of robotic welding workstation • Axes of six-axis robots • Metal surfacing • Thermal spraying • Hardfacing • Cladding • Buttering 	<ul style="list-style-type: none"> • Use computers to enter, access or retrieve data • Identify methods of changing appropriate technology for various applications (size, social and cultural). • Identify and select various types of metals • Identify and select various types of welding • Fabricate a product by hand. • Repair sheet metal products • Cut, assemble and pressure test components within various types of water supply systems • Identify the requirements of a safe water supply and treatment procedures that may be needed. • Define low, medium, and high carbon steel as well as plain carbon and alloy steel • Explain why alloys are added to steel • Arc weld both wrought and cast aluminum • Describe how to prepare and weld brass, bronze, titanium, and other non ferrous metals • Difference between pipe and tube • Weld pipe and tube using one or more welding processes • Explain when a particular cutting process would be chosen over another • Perform acceptable cuts and gouge on mild steel • Describe five habitats used for underwater welding 	<ul style="list-style-type: none"> • Curiosity

	<ul style="list-style-type: none"> • Difference between wet and dry welding • Requirements to become an underwater welder • Explain and identify parts of automatic and robotic welding • Identify the axis of six-axis robots • List reasons for considering thermal spraying for parts repair • Complete satisfactory surfacing beads • Identify and explain several thermal spraying methods 	
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Academic Vocabulary:

<ul style="list-style-type: none"> • Solid-state welding • Submerged arc welding • Consumable electrode • Narrow groove welding • Plasma arc welding • Transferred arc • Nontransferred arc • Explosion welding • Forge welding • Friction welding • Friction stir welding • Ultrasonic welding • Electroslag welding • Sonotrode • Electron beam welding • Accelerating voltage • Fishtail • Welding procedure specification • Nondestructive evaluation • Froof test • Halogen gas leak test • Backing ring • Backing tape • Air carbon arc cutting • Carbon arc cutting • Bottom time • Automatic welding • Flow switches • Servomotors • Stepper motor • Surfacing • Cladding • Hardfacing • Buttering • Buildup • Impact wear 	<ul style="list-style-type: none"> • Laser • Pumped • Coherent • Monochromatic • Ferrous metals • Heat affected zone • Cryogenic steels • High strength low alloy • Heat treatable low alloy • Aluminizing • Galvanizing • Maraging steels • Martensitic steels • Ferritic stainless steel • Austenitic stainless steel • Precipitation-hardening stainless steels • Temper carbon • Shielded metal arc cutting • Laser beam cutting • Laser beam drilling • Water jet cutting • Wet welding • Dry welding • Background gas • Semiautomatic welding • Mechanized welding • Industrial robots • Rectilinear robot • Articulated robot • Working volume • Program • Chemical corrosion • Hardness • Thermal spraying • Spalling 	<ul style="list-style-type: none"> • Nonferrous metals • Cast aluminum • Wrought aluminum • Thermoplastics • Thermosetting plastics • Pipe • Tube • Flange fitting • National Pipe Thread Tapered Thread • Flexible tubing • Rigid tubing • Compression fitting • Flared fitting • Quick disconnect couplers • Soldered connections • Brazed connections • Feathering • Downhill welding • Cover pass • Filler pass • Carbon equivalent • Knife switch • One-atmosphere pressure vessel • Ambient pressure chamber • Open bottom chamber • Dry spot welding • Cofferdam • Teach pendant • Offline • Set up point • Torch • Gun set up jig • Manual mode • Repeatability • Electric arc spray methodplasma
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Assessments:

- Test
 - Quizzes
 - Daily logs
 - Projects
 - Safety checks
 - Participation
-

Differentiation:

- Book work
 - Lecture
 - Demonstrations
 - Video clips
 - Hands on learning
 - IEP accommodations
-

Interdisciplinary Connections:

- This unit has strong interdisciplinary connections to science with all the different chemical reactions and physical transformations. The metals in this unit are ferrous and non ferrous requiring different techniques to weld.
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Additional Resources:

- Video clips
 - Articles
 - Personal Accounts
 - Modern Welding textbook
 - Welding Technology Fundamentals textbook
 - Agricultural Technology and Mechanics textbook
 - Math for welders textbook
 - Welding print reading textbook
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Advanced Welding and Pipe Fitting Grade 12

Unit #9

Course/Subject:
Advanced Welding and Pipe fitting

Grade:
12

Professional Welding

Suggested Timeline:
3-4

Grade Level Summary

Advanced Metal Engineering combines advanced instruction in Introductory Electric ARC and gas welding with hands-on training in the field of today's world of advanced metal working. This course includes instructions in welding processes including MIG, TIG, and Plasma processes in metal shaping and construction. Pipe fitting will be the second part of this course and will include the use and joining on PVC, steel, copper tubing used today in the Agricultural Industry.

Grade Level Units

Unit 1: Welding Fundamentals
Unit 2: Metal Technology
Unit 3: Shielded Metal Arc Welding
Unit 4: Gas Tungsten, Gas Metal, and Flux Cored Arc Welding
Unit 5: Oxyfuel Gas Processes; Metal Technology
Unit 6: Plasma Arc Cutting
Unit 7: Resistance welding
Unit 8: Special Processes
Unit 9: Professional Welding

Unit Title

Professional Welding

Unit Summary

This unit looks at what it takes to become a welder in the industry. It looks at qualifications welders must have and then how to get a job and hold it in industry. This unit helps students determine if the welding industry is something they want as a career.

Unit Essential Questions:

1. What qualifications does it take to become a welder?
2. What do you need to have a good job interview?

Key Understandings:

1. Inspecting and testing welds
2. Procedure and welder qualification
3. The welding shop
4. Getting and holding a job in the welding industry

Focus Standards Addressed in the Unit:

Standard Number

Standard Description

CRP.01.01.01.a

Define personal responsibility and distinguish how it applies in workplace and community.

CRP.10.01.01.b

Assess and select areas for growth and improvement based upon analysis of personal interests for potential careers.

CPR.10.01.02.a

Examine career clusters and identify potential career opportunities based on personal interests, talents, goals and preferences

Important Standards Addressed in the Unit:

Misconceptions:

1. Welding is job low income people and requires little skill.

Proper Conceptions:

1. Welding is a highly skilled trade that can earn someone a high salary depending on type of welding and location.
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Knowledge & Concepts	Skills & Competencies	Dispositions & Practices
<ul style="list-style-type: none">• Job interview process• Communication skills• Resumes• Calculate strength of weld• Workplace habits• Workplace behavior• Weld defects• Bend test• Peel test• Welding codes• Essential and nonessential welding variables• Weld qualification test• Shop welding equipment• Common welding shop tools• Careers in welding• Courses that relate to the field of welding• Job applications	<ul style="list-style-type: none">• Use computers to enter, access or retrieve data• Use telephone communication techniques• Fill out business or government forms.• Maintain accurate business and financial records• Fill out job applications• Fill out a resume• Perform well at a job interview• Differentiate between destructive testing and nondestructive examination methods• Visually inspect welds• Performs dye penetrate test on a weld• Make a safe and proper bend test on a groove weld• Identify governmental agencies that use and produce various types of welding codes• Weld test positions• Identify welding tools• Identify welding equipment found in a commercial welding shop• Identify jobs or careers in welding• Identify jobs that require apprenticeship or college degree• Develop the personal skills and qualities employees would like to see demonstrated by an employee• List reasons an employee that may cause an employee to lose his or her job.	<ul style="list-style-type: none">• Agency• Curiosity

Academic Vocabulary:

<ul style="list-style-type: none">• Discontinuities• Defects• Nondestructive examination• Nondestructive testing• Fitness for service• Critical defect size• Visual inspection• Magnetic particle inspection• Liquid penetrant inspection• Ultrasonic testing• Hertz• Transducer• Couplant• Impedance• Hydrostatic pressure testing• Transverse bends• Transverse face bend• Transverse root bend	<ul style="list-style-type: none">• Side bend• Longitudinal face and root bends• Unguided bend test• Fillet weld bend test• Tensile force• Tensile test• Elastic limit• Stress• Yield point• Yield strength• Ductility• Hardness• Rockwell C test• Brinell hardness testing machine• Microhardness test• Etch• Macroscopic• Chemical analysis	<ul style="list-style-type: none">• Contract• Procedure specifications• Welding procedure specifications• Test coupons• Welding procedure qualification record• Essential variables• Nonessential variables• Test specimens• Welder performance qualification test• Bending jig• Macro-examination-procedure specimens• Brake• Punch• Preheating furnace technical trade• Physics principles• Qualitative analysis• Quantitative analysis
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Assessments:

- Test
 - Quizzes
 - Daily logs
 - Projects
 - Safety checks
 - Participation
-

Differentiation:

- Book work
 - Lecture
 - Demonstrations
 - Video clips
 - Hands on learning
 - IEP accommodations
-

Interdisciplinary Connections:

- This unit has many connections to other courses. During the weld testing part of the unit, mathematical equations will be used to determine strength of welds and metal. Students will need their English skills of writing and communicating to fill out resumes and perform job interviews.
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Additional Resources:

- Video clips
 - Articles
 - Personal Accounts
 - Modern Welding textbook
 - Welding Technology Fundamentals textbook
 - Agricultural Technology and Mechanics textbook
 - Math for welders textbook
 - Welding print reading textbook
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