degrees that work. is a broadcast production of Pennsylvania College of Technology and WVIA public television.

More information is available at
www.pct.edu/degreesthatwork
or
www.wvia.org

This project is funded in part by the National Center for Welding Education and Training, a partnership of business and industry, community and technical colleges, universities, the American Welding Society and government that is doing business as Weld-Ed through funding support from the National Science Foundation under Grant No. 0703018. More information is available at www.weld-ed.org.

Pennsylvania College of Technology

An affiliate of The Pennsylvania State University

Penn College operates on a nondiscriminatory basis.
Unit: The Science of Welding and Welding Careers

Competency: Describe the process/science of fusing metals together through the process of welding and list and describe some career choices available in welding.

PA Academic Standards Included: 3.4.7B; 3.6.7C; 3.7.7A

Approximate Time: Four to five 45-minute periods.

Prerequisite Skills

Reading, Writing, Speaking and Listening*
None

Mathematics*
None

Science and Technology*
3.4.7 Physical Science, Chemistry and Physics
B. Relate energy sources and transfers to heat and temperature.
3.6.7 Technology Education
C. Explain physical technologies of structural design, analysis and engineering, personnel relations, financial affairs, structural production, marketing, research and design.
3.7.7 Technological Devices
A. Describe the safe and appropriate use of tools, materials and techniques to answer questions and solve problems.

Career Education and Work*
None

* Academic Standards, Pennsylvania Department of Education
http://www.pde.state.pa.us

Weld-Ed
National Center for Welding Education and Training

V0906
Competency: Describe the process/science of fusing metals together through the process of welding and list and describe some career choices available in welding.

### Performance Standards

<table>
<thead>
<tr>
<th>Performance Standard</th>
<th>Suggested Evaluation Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Describe the process/science of welding with a 90% accuracy level on the worksheet.</td>
<td>Written evaluation: worksheet</td>
</tr>
<tr>
<td>2. Describe the safety guidelines to follow when welding, based on the science of welding, with a 90% accuracy level on the worksheet and a discussion.</td>
<td>Written evaluation: worksheet</td>
</tr>
<tr>
<td></td>
<td>Oral evaluation: discussion</td>
</tr>
<tr>
<td>3. List and describe some of the jobs available in welding with 90% accuracy in a class discussion.</td>
<td>Oral evaluation</td>
</tr>
</tbody>
</table>

### Suggested Projects

None

### Multiple Intelligence Types

Verbal/Linguistic
Visual/Spatial

### Resources

1. PowerPoint - Welding  
The actual PowerPoint presentation can be obtained by contacting the Outreach for K-12 Office at Pennsylvania College of Technology at 570-320-8003 or CareerEd@pct.edu.

2. Handout - Science of Welding Worksheet  
See attached

3. Teacher resource - Science of Welding Worksheet Key  
See attached

4. Handout - Safety of Welding Worksheet  
See attached

5. Teacher resource - Safety of Welding Worksheet Key  
See attached

6. Video - Pennsylvania College of Technology “Degrees That Work”: Welding and Fabrication  
http://www.pct.edu/degreesthatwork/welding.htm

7. Teacher resource - Lincoln Electric Welding Curriculum  
http://www.lincolnelectric.com/knowledge/training/weldcurriculum.asp

### Equipment/Materials/Software

1. Computer with internet access  
Any supplier

2. Video projector  
Any supplier

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Weld-Ed  
National Center for Welding Education and Training

V0906
### Suggested Learning Sequence

<table>
<thead>
<tr>
<th>Strategy</th>
<th>Outline</th>
<th>Resources/Equipment</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Performance Standard 1</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Introduction/Discussion</td>
<td>Have a discussion of how science relates to different careers. Lead the students to welding and the science of welding.</td>
<td></td>
</tr>
<tr>
<td>Presentation/Activity</td>
<td>Use the science portion of the Welding PowerPoint to teach the students about welding and four concepts of science related to welding. As you are covering the science material on welding have the students fill out a worksheet. <strong>Related Academic Skills:</strong> 3.4.7B; 3.6.7C <strong>Related SCANS/Soft Skills:</strong> Information A</td>
<td>Resource #1 (science section) Resource #2 Resource #3 Equipment #1 Equipment #2</td>
</tr>
<tr>
<td><strong>Performance Standard 2</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Introduction/Discussion</td>
<td>Review the science of welding and lead the students into a discussion on safety. Use what they learned in the science section to come up with some safety issues.</td>
<td>Resource #1 Equipment #1 Equipment #2</td>
</tr>
<tr>
<td>Presentation/Activity</td>
<td>Use the safety portion of the Welding PowerPoint to teach the students about the safety issues associated with welding. Tie in what they learned about the science of welding to understand safety issues. As you cover the safety portion of the PowerPoint have the students fill in the Safety of Welding worksheet. <strong>Related Academic Skills:</strong> 3.7.7A <strong>Related SCANS/Soft Skills:</strong> Information A</td>
<td>Resource #1 (safety section) Resource #4 Resource #5 Equipment #1 Equipment #2</td>
</tr>
<tr>
<td><strong>Performance Standard 3</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Presentation/Discussion</td>
<td>Show the students the video about welding careers. Before its showing, explain that they are to identify welding related jobs that are demonstrated or mentioned in the video. At the conclusion of the showing, have students identify the related careers in the video and list them on the board. Make sure they know generally what these jobs entail. Ask if they know anyone who has a welding related job and have them describe exactly what they do on the job. <strong>Related SCANS/Soft Skills:</strong> Information A</td>
<td>Resource #6</td>
</tr>
<tr>
<td>Assessment/Discussion</td>
<td>Check for students understanding of the science and safety of welding and related careers with a post unit</td>
<td>Resource #1 Resource #2</td>
</tr>
</tbody>
</table>
Competency: Describe the process/science of fusing metals together through the process of welding and list and describe some career choices available in welding.

Related Academic Skills: 1.6.8D

<table>
<thead>
<tr>
<th>Optional Exercise</th>
<th>Description</th>
<th>Resources</th>
<th>Equipment</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Optional for schools with available welding equipment in one of their shops - Technology Education, Agriculture, Automotive, etc.)</td>
<td></td>
<td>Resource #4 Equipment #1 Equipment #2</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Introduction/Discussion</th>
<th>Description</th>
<th>Resources</th>
<th>Equipment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Discuss with the students the proper procedures for welding including safety.</td>
<td></td>
<td>Resource #7 Equipment #1 Equipment #2</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Presentation</th>
<th>Description</th>
<th>Resources</th>
<th>Equipment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Have the shop/vocational teacher demonstrate the welding procedure to the students. After checking for understanding and reviewing safety, have the students demonstrate the welding process and explain what is happening scientifically as they weld.</td>
<td></td>
<td>Resource #7 Equipment #1 Equipment #2</td>
<td></td>
</tr>
</tbody>
</table>

Related SCANS/Soft Skills

**Resources**
None

**Interpersonal**
None

**Information**
A. Acquires and Evaluates Information

**Systems**
None

**Technology**
None

**Thinking Skills**
None

**Personal Qualities**
None

Related Worksite/Work Based Activities
None

Additional Resources
None

This planning guide was written by Eric Broughton, Physics/General Science Teacher, Liberty Jr./Sr. High School, Liberty, PA.
The Science of Welding

Science Worksheet

Name: __________________________________ Date: __________________________

Instructions: Fill out the worksheet as we cover the science of welding with a PowerPoint.

1. __________________ welding is a process used to join two pieces of similar metals together.
2. A welder uses __________________ energy to heat metal until it is molten.
3. List 3 things that you use in your life that require welding.
   a. 
   b. 
   c. 
4. The electrical potential or pressure that causes current to flow is called __________________ and it is measured in __________________.
5. The movement of charged particles in a specific direction is a called __________________ and it is measured in __________________.
6. __________________ deals with the direction of electron flow.
   a. __________________ current has electrons flowing toward the work surface.
   b. __________________ current has electrons flowing away from the work surface.
   c. __________________ current has electrons changing directions toward and away from the work surface.
7. The electricity flows from the __________________, through the __________________ and across the ________________, through the _________________ to the work lead and back to the _____________________.
8. The process or system above that deals with the path that electricity follows is called a _____________________.
9. The electron flow in the circuit is what causes an __________________ to be formed.
10. The arc created by the ___________________ is converted into heat because of the _________________ of electron flow.
11. The heat that is created ___________________ the metal and fuses the pieces together.
12. The changing of energy from one form into another is called ___________________ _____________________.


13. During welding _______________________ energy is converted into _______________________ energy.

14. Name 4 types of energy.
   a. 
   b. 
   c. 
   d. 

15. During the welding process the metal changes ____________________________.

16. The 4 types or states of matter are ________________________,
    ________________________, ________________________, and ________________________.

17. List the changes of state the metal goes through during the welding process.

18. Name the three elements that can react with the weld pool and weaken the weld.
   a. 
   b. 
   c.
The Science of Welding

Science Worksheet Key

Name: ____________________________ Date: __________________________

Instructions: Fill out the worksheet as we cover the science of welding with a PowerPoint.

1. _____ Arc ________ welding is a process used to join two pieces of similar metals together.

2. A welder uses ___ electrical _____________ energy to heat metal until it is molten.

3. List 3 things that you use in your life that require welding.
   a. Answers will vary. Anything that is welded will be correct
   b. 
   c. 

4. The electrical potential or pressure that causes current to flow is called __ voltage ________ and it is measured in __ volts ____________.

5. The movement of charged particles in a specific direction is a called __ current ____________ and it is measured in __ amps ______________.

6. __ Polarity ____________ deals with the direction of electron flow.
   a. __ DC - __________ current has electrons flowing toward the work surface.
   b. __ DC + __________ current has electrons flowing away from the work surface.
   c. __ AC __________ current has electrons changing directions toward and away from the work surface.

7. The electricity flows from the __ Power Source __________, through the __ electrode __________ and across the __ arc __________, through the __ base material __________ to the work lead and back to the __ power source ________________.

8. The process or system above that deals with the path electricity follows is called a __ circuit ________________.

9. The electron flow in the circuit is what causes an __ arc ____________ to be formed.

10. The arc created by the __ electric _______ current __________ is converted into heat because of the __ resistance ____________ of electron flow.

11. The heat that is created __ melts ________________ the metal and fuses the pieces together.

12. The changing of energy from one form into another is called __ energy __________ __ conversion _________________.


13. During welding ___electrical___________ energy is converted into ___thermal________________ energy.

14. Name 4 types of energy.
   a. electrical
   b. thermal
   c. chemical
   d. radiation

15. During the welding process the metal changes __states__________________.

16. The 4 types or states of matter are __solid________________, __liquid__________, __gas__________, and ___plasma__________________.

17. List the changes of state the metal goes through during the welding process.
   Solid to liquid and gas to solid

18. Name the three elements that can react with the weld pool and weaken the weld.
   a. Hydrogen
   b. Nitrogen
   c. Oxygen
Science of Welding

Safety Worksheet

Name: ____________________________________ Date: ___________________________

Instruction: Fill out the worksheet on welding safety as you watch the PowerPoint

1. What three science concepts related to welding makes safety an important topic?
   a. 
   b. 
   c. 

2. For welding to be safe you must understand and follow all ________________________.

3. List three places to find warning labels for welding safety.
   a. 
   b. 
   c. 

4. What is a MSDS?

5. List five potential hazards you need to protect yourself from when welding.
   a. 
   b. 
   c. 
   d. 
   e. 

6. List five safety devices worn by a welder to protect themselves.
   a. 
   b. 
   c. 
   d. 
   e.
Science of Welding

Safety Worksheet Key

Name: ____________________________________ Date: ___________________________

Instruction: Fill out the worksheet on welding safety as you watch the PowerPoint

1. What three science concepts related to welding makes safety an important topic?
   a. Electricity
   b. Chemical Reactions
   c. Changes of State

2. For welding to be safe you must understand and follow all ___DIRECTIONS______.

3. List three places to find warning labels for welding safety.
   a. On Equipment
   b. On consumable materials package
   c. In the instructions

4. What is a MSDS?
   A material safety data sheet – provided by manufacturer to inform of safe handling, potential hazards, identity and composition, and safe use of the material.

5. List five potential hazards you need to protect yourself from when welding.
   a. Fumes and gases
   b. Electric Shock
   c. Arc Rays
   d. Fire and Explosion and hot objects
   e. Noise

6. List five safety devices worn by a welder to protect themselves.
   a. Fire proof clothing
   b. Work boots
   c. Welding gloves, jackets and pants
   d. Welding cap, helmet and safety glasses
   e. Ear protection