Welding

Description
Oxyacetylene or fusion welding is one of the oldest methods of joining metal. Oxyacetylene welding equipment is very common in an automotive shop and has many uses. It is most often used to heat or cut seized or rusted parts that cannot be removed in other ways, or to weld small, thin metal pieces such as exhaust tubing and brackets.

Lesson Outcomes
The student will be able to:
- Safely inspect and light, operate and shut down an oxyacetylene welding torch.
- Weld a simple joint and demonstrate heating skills using the equipment in the automotive shop.

Assumptions
It is expected that the students will not have previously used oxyacetylene welding equipment and will not have previously learned skills specific to its use.

Terminology
Acetylene cylinder: a strong, welded steel container that is specially designed to store acetylene, a highly unstable and explosive gas. Acetylene cylinders must be kept upright when in use.

Acetylene regulator: used to regulate acetylene pressure from the cylinder to the mixer handle. The acetylene gas regulator is usually coloured red.

Figure 1—Typical acetylene regulator
“Beanie”: small skullcap hat used to protect the scalp from sparks

**Coupon**: typically small, pre-cut pieces of metal (roughly the size and shape of a “coupon”) used for practice welds

**Gas hoses**: connect the regulator to the mixer handle

**Goggles**: specially darkened glasses used to protect a welder’s eyes from the welding flame

**Oxygen cylinder**: cylinder forged from a single piece of strong, high-carbon steel with walls at least 6 mm (¼”) thick. Oxygen is stored in these cylinders under enormous pressure.

**Oxygen gas regulator**: used to regulate oxygen pressure from the cylinder to the mixer handle. The oxygen gas regulator is usually coloured green.

![Figure 2—Typical oxygen regulator](image1)

**Striker**: the only approved means of lighting an oxy-fuel torch. Also known as a *flint lighter* or *spark lighter*, the steel cup traps the gas, and when the flint contacts the file segment it produces a spark that ignites the fuel gas. The model shown in Figure 3 is the most common type, though pistol grip strikers are also available.

![Figure 3—Striker](image2)
Tip cleaner: steel tip-cleaning needles with tiny file-like teeth, designed to loosen oxides and slag from the welding tip orifice

Torch handle: mixes and regulates the acetylene and oxygen gas flow to the welding tip. It also has a threaded end for changing to different tips. Sometimes called the mixer handle.

Welding apron or jacket: protective gear worn over work clothes to prevent burns

Welder’s gloves: gloves designed to protect the welder’s hands from burns, usually made from soft cowhide leather

Welding cart: portable cart used to store and transport welding cylinders. The cart is designed to store the cylinders upright in a stable and secure position when stationary, and to roll easily when tilted back on its wheels.

Welding filler rod: a steel rod that comes in different thicknesses to help weld the pieces together.

Welding tip: screws onto the torch handle. It comes in different sizes and is changed depending upon the thickness of the metal to be welded or the area to be heated.

Estimated Time
60–120 minutes

Recommended Number of Students
20, based on the BC Technology Educators’ Best Practice Guide

Facilities
A regular automotive or welding shop with vises and metal-top benches

Tools
An operational oxyacetylene welding unit (preferably more than one unit), with attachments enabling use of more than one torch per unit. Installing equipment to accommodate a “Y” formation allows for the use of two stations per bottle.
Materials

- Sufficient lengths of metal plates (coupons) for each student to practice (½” × 2” × 4”). Mild steel flat bar works well.
- Two pieces of exhaust tubing cut into 1” slices for each student is sufficient for first-time practice.
- Sufficient ½” oxyacetylene welding rods for each student
- Oxyacetylene welding gloves and glasses or shaded face shields for each student

Resources

Oxyacetylene Welding (OAW)
PowerPoint presentation created by the York County School of Technology. Once you click on the link below, this resource should appear in your downloads folder.
http://tinyurl.com/qfdl4fs

Oxy-Acetylene Welding and Cutting
Good technical information. Geared more toward instructors than students.
www.esabna.com/euweb/oxy_handbook/589oxy2_1.htm

Oxy-Acetylene Welding
Steve Biele’s instructional video, available at low cost
www.weldingvideos.com/oawelding.html

ESAB Training Victor Videos
https://vimeo.com/esabtraining

Lighting Procedures Handout
See the handout at the end of this Activity Plan.

Safety Tests
Generic safety tests are available in the Heads-Up for Safety! resource that can be found at:
www.bced.gov.bc.ca/irp/resdocs/headsup.pdf

An oxyacetylene safety information sheet can be found on page 85 of the document; a quiz is included on page 86.
Activity

1. Have the students work in pairs to assist each other. Demonstrate the process of setting up and lighting the torch and then have each student display their ability to do the same.

2. When each pair has shown mastery of lighting and shutting the torch down, the students can assist each other or practise welding their pieces of pipe together.

3. When students are comfortable with lighting and shutting down the system and the pipe welding component, they can move on to the next stage. The teacher should demonstrate changing to the larger heating tip and should show how it operates. Then have students demonstrate.

4. Students can then practise heating the samples of metal (coupon) while the teacher supervises. The students should be shown how to bend the metal into proper 90° angles.

5. When both coupons are bent to form right angles, they can then be welded together to form a box with both ends open. This exercise will allow students to practise accurately attaching the pieces.

6. If any very rusty pieces of metal bolted together are available, they make excellent demonstration pieces for heating nuts and bolts to remove seized parts.

Evaluation Guidelines

• Proficiency and safe operation of the oxyacetylene equipment is a priority.
• Accuracy is also an essential consideration when heating and bending metal to specified angles.

The information below explains how visual appearance can help determine the quality of penetration in a weld.

Speed of Travel and Movement

Speed of travel (rate of travel) is a very important factor in producing good fusion welds. The speed of travel depends on the base metal thickness, the welding joint design and the volume of heat produced by the welding torch.

If your speed of travel is too fast, the weld bead becomes too narrow and the bead ripples become pointed. The heat has not penetrated and the result is lack of fusion (Figure 5).

![Figure 5—Weld bead formed when speed of travel was too fast](image-url)
If your speed of travel is too slow, it will result in too much penetration and a scaly appearance on the weld bead (Figure 6).

![Figure 6—Weld bead formed when speed of travel was too slow](image)

If you allow too much heat to build up, the molten weld pool will collapse through to the bottom of the plate and leave holes (Figure 7). The underside of the weld might have molten metal that has solidified, forming icicle-like structures.

![Figure 7—Weld bead formed with too much heat](image)

If you complete your weld properly, it will have uniform bead ripples, even bead width and a shiny surface appearance (Figure 8).

![Figure 8—Weld bead formed correctly](image)

The movement of the torch is also extremely important. As soon as there is a small weld pool (pool of molten weld metal), start to move the torch forward with a side-to-side or circular motion. At the same time, insert the end of the filler rod into the weld pool, dipping the rod into and out of the weld pool. The filler rod should be withdrawn just enough to remove it from the weld pool, but not entirely from the flame, since it should not be allowed to oxidize or cool.

Coordinating the motion of the filler rod and the motion of the welding torch is an important factor in producing a quality weld. You will become better at this with continued practice.
Oxyacetylene Lighting Procedures for Welding Mild Steel

Lighting Up the Torch

1. Ensure the tanks are upright and secure.
2. Check the welding area for any flammables that should be removed (paper towel, spray cans, etc.).
3. Unravel the welding hoses.
4. Make sure the regulator T-handles are turned out loose.
5. Open the acetylene tank ½–¾ turn.
6. Open the acetylene torch valve ½ turn.
7. Screw in the acetylene regulator T-handle adjusting valve to working pressure. (For welding, always use tip size for pressure.) NEVER go beyond 15 psi. This makes the acetylene very unstable and potentially explosive.
8. Turn off the acetylene torch valve.
9. Open the oxygen tank valve all the way.
10. Open the oxygen torch valve ½ turn.
11. Screw in the oxygen T-handle adjusting valve to working pressure. (For welding, always use tip size for pressure.)
12. Turn off the oxygen torch valve.
13. Ensure you are wearing all necessary safety equipment (goggles, gloves, apron, etc.).
14. Open the acetylene torch valve ¼ turn, then light the acetylene using a striker.
15. Open up the acetylene torch valve until most of the smoke/soot disappears.
16. Slowly open the oxygen torch valve until a neutral flame is achieved.

Figure 9—Correct striker position
**Shutting Down the Torch**

1. Close the acetylene torch valve.
2. Close the oxygen torch valve.
3. Close the acetylene tank valve.
4. Close the oxygen tank valve.
5. Back out the acetylene regulator T-handle until loose.
6. Open the acetylene torch valve to drain the pressure. Both the tank pressure and line pressure regulator gauges should read 0.
7. Close the acetylene torch valve.
8. Back out the oxygen regulator T-handle until loose.
9. Open the oxygen torch valve to drain the pressure. Both the tank pressure and line pressure regulator gauges should read 0.
10. Close the oxygen torch valve.
11. Wrap up the welding hoses.
12. Clean the welding area.

**Remember!**

*Acetylene on first, acetylene off first.*