Solvent Welding

Description
Students will learn to correctly prepare, assemble, and solvent weld ABS piping.

Lesson Outcomes
The student will be able to:

• Accurately cut plastic piping
• Prepare plastic piping for solvent welding
• Safely solvent weld plastic piping

Assumptions
The teacher is familiar with the tools, materials, and procedures related to solvent welding.

Terminology
ABS: an acronym for acrylonitrile butadiene styrene; the most common plastic pipe used for drainage, waste, and venting (DWV) in British Columbia.

Dry fit: a technique commonly used to prepare for installation of piping. With dry fit installation, small sections of pipe and fittings are pushed together without solvent cement so they can be easily disassembled. When sections of pipe are confirmed to be correct, fittings are disassembled and bonded with solvent cement.

Materials Safety Data Sheet (MSDS): information specific to an individual product’s safe usage and handling.

Solvent weld: the process of using a liquid solvent to chemically bond plastic pipe and fittings.


Estimated Time
2–8 hours

Recommended Number of Students
Activities could be done individually or in pairs.
Facilities

Shop setting with flat, stable working surface (student benches). Access to water (hose) required for testing. Solvent welding gives off strong fumes. Good ventilation or an outdoor area is advisable.

The preferred method of holding pipe for beginners is a chain vise available in portable (Figure 1) or bench-top versions. Alternatively, a standard wood vise or a flat surface upon which the pipe could be held securely would suffice.

![Figure 1—Portable chain vise for holding pipe](image)

Tools

ABS pipe can be cut in several ways. The most common method in industry is using a hacksaw with a 14–18 tooth blade. Alternatives include:

- Reciprocating saw
- Hand saw with mitre box
- Tubing cutter with plastic cutting wheel
- Mitre saw
- Plastic pipe cutter (Figure 2)
Materials

- An assortment of 1½”, 2”, and 3” diameter ABS pipe, depending on activity

- ABS solvent cement (yellow), generically referred to as glue. Technically, solvent cement is the correct term, as the solvent chemically softens the plastic surfaces before bonding occurs as the solvent evaporates.

- ABS fittings (type and quantity depending on activity): 45° bends, 90° bends, 22° bends; wyes, tees, caps, reducers, line cleanouts. See below for fittings commonly available at plumbing wholesalers or retail outlets.

Figure 2—Ridgid FC-200 capable of cutting ABS pipe up to 2”

Figure 3—ABS 45°. The hub by hub 45 shown on the left connects two pieces of piping. The hub by spigot 45 shown on the right fits directly into another fitting (typically a wye).
Elbows are available as fittings, meaning one end can fit directly into another fitting without adding further pipe. The 45° elbow may also be referred to as a ¼th bend, as 45° represents ¼th of a full circle (360°).

Also available as fitting 90s and may be referred to as ¼ bends.

Many combinations of outlet sizes are available. Note how the throat of the branch directs the flow of waste moving through the fitting.
This fitting with its removable plug is a mandatory part of any drainage system. The plug must be located so it may be removed for inspection or cleaning if a blockage occurs within the system.

The trap provides a water seal that prevents sewer gas from coming into the living space. Traps are connected below basins, showers, and bathtubs. The trap for a toilet is located within the bowl, so a p-trap does not need to be connected.

![Figure 8—ABS line cleanout](image)

![Figure 9—ABS p-trap](image)

![Figure 10—A cutaway view of a p-trap](image)

![Figure 11—ABS water closet floor flange](image)
The flange must be securely attached to the floor using brass screws. The flange then provides a sturdy platform upon which a toilet (also known as a *water closet*) can be fastened. Brass screws, bolts, and washers are used below a toilet as they are highly resistant to corrosion.

![ABS bushing](image)

**Figure 12**—ABS bushing

Bushings fit inside a fitting to facilitate a reduction in the size of piping.

**Resources**

Solvent welding literature and link to online training system; general information with a specific focus on two-stage solvent welding for PVC pipe


ABS solvent welding video

http://www.youtube.com/watch?v=bLstgZCREPc

ABS solvent welding information sheet

http://www.arrowadhesives.com/HowTo.html

WHMIS information and resources

http://www2.worksafebc.com/Topics/WHMIS/Home.asp

MSDS for ABS solvent cement

Activity 1: Cut Pipe Squarely and Accurately

Have students cut 10 pieces of ABS 1” long. The students can lay out the pieces flat on a table to check for consistency and straightness. Industry tolerance is typically +/- ¼” accuracy of length. As described in the “Tools” section, many methods of cutting ABS are available. The teacher could have students practise several methods. In addition, cutting with a hacksaw can be practised in several positions. Plumbers should be able to cut pipe accurately in whatever environment they are working. This includes trenches, crawlspace, or even seated in front of a cabinet. Students could practise by supporting the pipe with a chain vise, ladder, or even with no support (seated on the floor) (Figure 13).

Burrs on the inside and outside edges of pipe should be removed by hand, rag, utility knife, or file. A de-burring tool could also be used. Outside burrs interfere with the insertion of the pipe into the fitting, while inside burrs may interfere with the free flow of materials through the pipe (Figure 14).

Figure 13—Cutting ABS with only a ladder support can be challenging at first.  
Figure 14—Cutting ABS in a seated position

Figure 15—Ridgid de-burring tool to remove burrs on inside and outside edges of pipe
A wraparound (emery cloth or sand cloth are cost-effective substitutes) used to mark a perpendicular guideline provides a useful technique for beginners to mark their cuts.

![Image]

**Figure 16**—Positioning a wraparound to mark the cut line.

Students align the wrap and mark the pipe with pencil, permanent marker, or paint marker. This method is useful on larger diameter piping, which students tend to cut crookedly. The markings give student immediate feedback to determine if they are maintaining a straight cut.

![Image]

**Figure 17**—Marking a square line helps novices to produce square cuts.
Activity 2: Cut ABS Pipe with Reciprocating Saw

Have students cut 10 pieces of ABS, each 1" long, using a reciprocating saw (Figure 18). Students must wear eye protection and keep the guide tight to the pipe. A 12–18 tooth blade will quickly remove cut material and reduce the amount of melted material. Burrs produced by this method of cutting tend to be more difficult to remove, so a file or utility knife is likely to be needed.

Figure 18—Reciprocating saws cut ABS pipe very quickly.
Activity 3: Assemble Piping

Have students assemble a small system of fittings and pipe to given dimensions using ABS solvent cement. See the ABS starter drawing (Figure 19) as an example. Pairs of students could build letters to spell their school’s name. There are also many games involving throwing beanbags or rings that could be built.

**Note:** Assembled fittings and pipe can only be disassembled within minutes of solvent welding. Within a period of 24 hours, maximum bonding strength occurs, and fittings become extremely difficult to remove from pipe.

Safety: Students should wear eye protection and gloves when working with ABS solvent cement. Appropriate safety measures and first aid information can be found in the MSDS.

- Have students work with a partner to create their assigned letter.
- All letters must be a maximum of 16" tall and 12" wide.
- Students must dry fit all pipe and fittings before they are permitted to solvent weld.

![Figure 19—Sample ABS starter project](image-url)
Activity 4: Sculpture

Have students design and create an object from ABS pipe and fittings. See Figure 20 as an example.

- Students sketch an object they wish to construct, including dimensions. Alternatively, an open-ended design technique could be employed. For example, a list of fittings and a given length of pipe could be made available to each student.

- Students cut pipe and dry-fit fittings. For the purposes of disassembly and modelling correct solvent welding technique, a small brush with white grease can be used. The grease serves as a lubricant that will make the fittings much easier to disassemble or reuse. The grease must be removed with a rag before solvent welding occurs.

Parts List

• (4) 1½” 45° elbows
• (4) 1½” tees
• (4) 1½” cross
• (6) 1½” 90° elbows

Procedure

• Have students sketch a 3-D object that will be built with ABS pipe and fittings.

• Students are permitted a maximum of 20 fittings and 6’ of pipe.

• Students must have their designs approved by the teacher before constructing their sculptures.
Activity 5: Integrated Activity

Students assemble drainage piping for use in draining a washroom. See Figure 22 as an example.

The teacher will explain to students that they will be assisted in designing a draining system to accommodate all fixtures.

• Have students draw the drainage system, including the pipe size (Figure 23).
Teacher Notes

- See Figure 24 for further detail.
- 2” to LAV is necessary for venting of other fixtures.
- Indicated dimensions are available from manufacturer’s specifications online.

Notes/Specifications

Fixture schedule (see manufacturer’s documentation for location of drains)

- WC – American Standard Champion Model 5325010
- LAV – American Standard Studio Above Counter Model 0621001
- SH – Maax Cyrene Model 300001

Wall Schedule

- 2 × 4” wall with ½” drywall (actual width of wall will be 3½” + drywall)
Teacher Notes

- Depending on time available, it may be easier to provide students with all dimensions and a layout of piping.

- Piping must be supported so it will not move when filled with water. A common method for this is the use of \( \frac{1}{2} \)" strap iron (Figure 25).

- Horizontal piping should be graded at \( \frac{1}{4} \)" per linear foot of pipe. An approximation of one-quarter bubble on a level would suffice (Figure 26).

- When piping is complete and open ends are capped, a water test can be performed. This involves filling the system with water and checking for leaks. The water test is conducted on all drainage systems for a local inspector.

- Once a wall finish (drywall or tile) is complete, fixtures including p-traps may be connected to the drainage system.

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**Figure 25**—Strapping is a cost-effective way to support piping. Use screws through the perforations to support horizontal or vertical piping.

**Figure 26**—A torpedo level can indicate horizontal level, vertical plumb, and 45° angle. Some models can also indicate grade (angle) of piping. A level showing approximately one-quarter of the bubble above horizontal can be used as an approximation of $\frac{1}{4}''$ per foot.

**Evaluation Guidelines**

The student:

- Assembles pipe and fittings accurately to given dimensions. Suggested tolerance of $\frac{1}{8}''$.
- Cuts pipe square.
- Assembles joints correctly.
- Removes excess solvent cement.
- Follows all safety procedures.
- Assembles pipe and fittings so they are able to hold water.