

POTATOES, BEWARE

The potato cannon, a.k.a. the spud gun, is a popular and very entertaining amateur science project. It's simple to make, and few devices offer such bang for the buck. You can use the Night Lighter both day and night, but when it's dark, the clear PVC provides an excellent view of the interior ballistics. Also, the stun gun gives better performance than weaker sparks from piezoelectric or flint/steel igniters. It's fun both to fire and simply to watch in action.

A basic spud gun can be built with plain, white PVC for less than \$25. The Night Lighter 36 costs more, but I scrounged leftovers from plastics suppliers and built mine for less than \$50. After mastering basic gun construction, the intrepid potato cannoner may want to design and assemble more complex and artistic devices.

Zoom In Page 110

William Gurstelle enjoys making interesting things that go whoosh then splat. He is the author of *Backyard Ballistics* (2001), *Building Bots* (2002), and *The Art of the Catapult* (2004). Visit backyard-ballistics.com for more information.

PRINCIPLES OF SPUD GUNNERY:

Serious spud gun designers tinker with the ardor of hot-rod builders. Our NL-36 improves upon the basic potato cannon by substituting transparent tubing and a stun gun igniter.

BEVELED EDGE Load a spud, and the sharpened front edge cuts a plug that seals airtight against the barrel.

BARREL The three-foot barrel guides the potato plug along its trajectory as it picks up speed from the explosion.

IGNITION CHAMBER A spark from a stun gun ignites hydrocarbon-rich aerosols, causing the internal combustion that sends the spud. You can watch it all through the clear PVC.

CHEMICAL REACTION Fire, everyone's favorite exothermic reaction, breaks aerosol propellants into hot, expanding CO₂ and water vapor.

RANGE COMPARISONS WITH OTHER FAMILIAR PROJECTILES
Our spud gun propels a 9-ounce potato plug approximately 200 yards. Here's how this compares with some other launch events.

Shot put: 16 pounds, 25 yards (Olympic record)
Cell phone toss: 4-5 ounces, 90 yards (Savonlinna record)
Football punt: 14-15 ounces, 98 yards (NFL record)
Baseball throw: 5.25 ounces, 149 yards (Guinness record, 1957)
Civil War cannon: 6-pound ball, 1,500 yards
SCUD-B missile carrying 10-ounce potato payload: 186 miles

Illustration by Tim Lillis

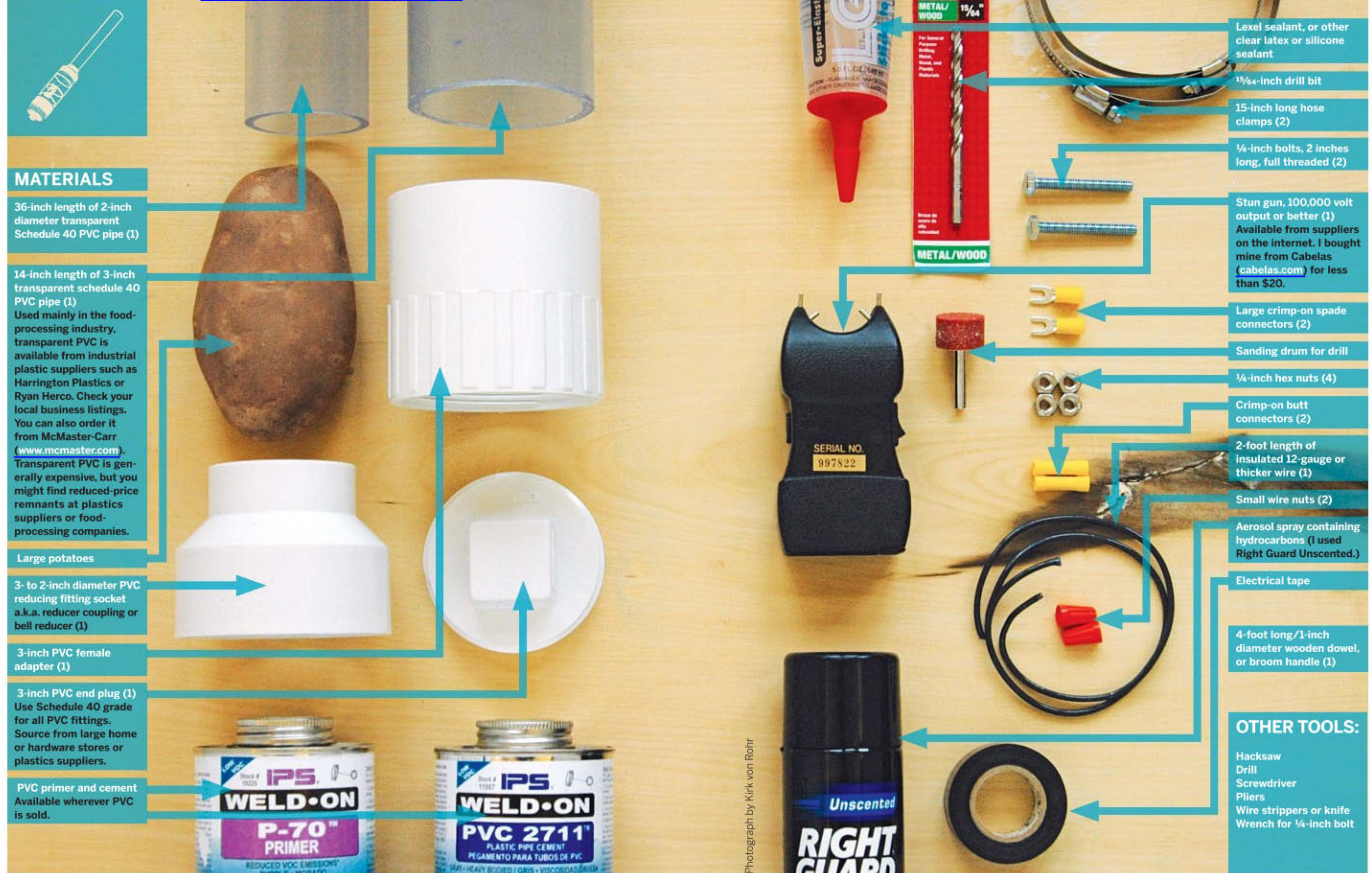
Not to scale.

PROJECTS: SPUDGUN

www.makezine.com/03/spudgun

SET UP.

Visit [makezine.com/03/spudgun](http://www.makezine.com/03/spudgun) for source list.



MATERIALS

- 36-inch length of 2-inch diameter transparent Schedule 40 PVC pipe (1)
- 14-inch length of 3-inch transparent schedule 40 PVC pipe (1)
Used mainly in the food-processing industry, transparent PVC is available from industrial plastic suppliers such as Harrington Plastics or Ryan Herco. Check your local business listings. You can also order it from McMaster-Carr (www.mcmaster.com). Transparent PVC is generally expensive, but you might find reduced-price remnants at plastics suppliers or food-processing companies.
- Large potatoes
- 3- to 2-inch diameter PVC reducing fitting socket a.k.a. reducer coupling or bell reducer (1)
- 3-inch PVC female adapter (1)
- 3-inch PVC end plug (1)
Use Schedule 40 grade for all PVC fittings. Source from large home or hardware stores or plastics suppliers.
- PVC primer and cement
Available wherever PVC is sold.

- Lexel sealant, or other clear latex or silicone sealant
- 15/64-inch drill bit
- 15-inch long hose clamps (2)
- 1/4-inch bolts, 2 inches long, full threaded (2)
- Stun gun, 100,000 volt output or better (1)
Available from suppliers on the internet. I bought mine from Cabelas (cabelas.com) for less than \$20.
- Large crimp-on spade connectors (2)
- Sanding drum for drill
- 1/4-inch hex nuts (4)
- Crimp-on butt connectors (2)
- 2-foot length of insulated 12-gauge or thicker wire (1)
- Small wire nuts (2)
- Aerosol spray containing hydrocarbons (I used Right Guard Unscented.)
- Electrical tape
- 4-foot long/1-inch diameter wooden dowel, or broom handle (1)

OTHER TOOLS:

- Hacksaw
- Drill
- Screwdriver
- Pliers
- Wire strippers or knife
- Wrench for 1/4-inch bolt

Photograph by Kirk von Rohr

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MAKE IT.



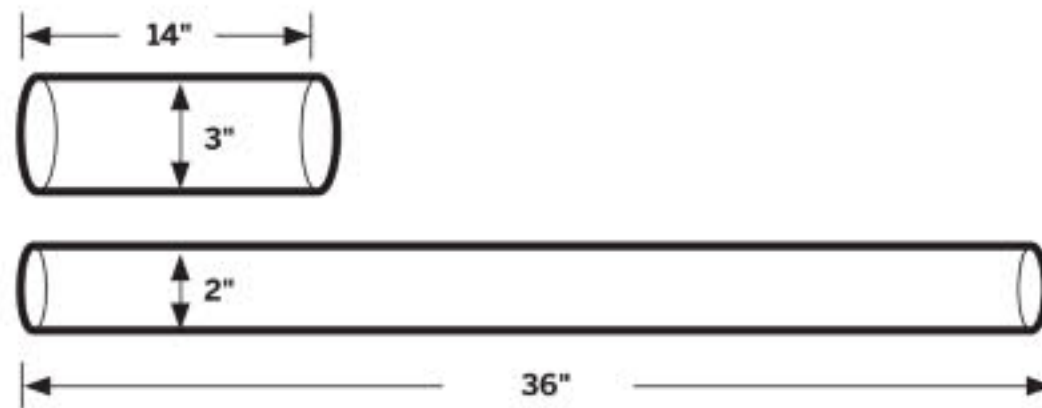
CONSTRUCTING THE MIGHTY POTATO CANNON

START

Time: An Afternoon Complexity: Low

1. PREPARE THE PVC

1a. Cut pipes. Measure and mark a cutting line 14 inches from one end of the 3-inch diameter PVC pipe. Use the hacksaw to cleanly and squarely cut the pipe. This will be the cannon's combustion chamber. Then measure, mark, and cut a 36-inch length of the 2-inch diameter PVC pipe. This will be the cannon's barrel.



1b. Taper end of gun. Use a file or a drill and sanding attachment to taper one end of the long 2-inch diameter pipe, so that it forms a sharp edge. A clean, sharp edge is important, since it should cut the perfect-sized potato plug projectile as you ram the potato into the muzzle of the gun.



When PVC gets hot, it releases poisonous chlorine gas. Perform this step in a well-ventilated area.

2. ATTACH THE ELECTRODES

2a. Drill electrode holes. Four inches from one end of the 3-inch diameter pipe, drill a slightly undersized hole for the 1/4-inch bolt. Drill a second hole directly opposite the first hole, four inches from the end.



The 3-inch pipe will contain the fuel and the spark, and act as the combustion chamber.

2b. Attach electrodes. Screw in the 2-inch long bolts, with nuts attached (two per bolt), into the holes in the 3-inch pipe. The nuts go outside the barrel. The bolts should tap themselves into the softer plastic, but don't over-tighten or you'll strip the PVC. Position and adjust the nuts as needed so there is a 1/4-inch gap between the bolt ends inside the barrel.



This is the spark gap that will ignite the fuel, firing the cannon.

3. SOLVENT-WELD THE PVC

The spud gun is composed of PVC pipes and fittings that are solvent-welded in place using PVC cement and primer. To prevent leaks and weak spots where the parts are joined, the solvent welding must be done properly. Meanwhile, the primer and cement are toxic and flammable, so you need to work in a well-ventilated area, keep the chemicals away from open flames, and follow all safety precautions on the labels. First, we'll solvent-weld the reducing connector to the front of the combustion chamber. Then we'll follow the same procedure to attach the threaded adapter to the back of the chamber and to connect the barrel.

3a. Inspect parts. Check the 3-inch pipe ends and 3- to 2-inch reducing connector for cracks, dirt, and abrasion, and remove any plastic burrs with a knife. Don't use damaged PVC pipe or fittings.

3b. Weld parts. Following the procedure at right, solvent-weld the 3- to 2-inch reducing connector to the end of the 3-inch pipe closest to the electrode bolts. Then join the unthreaded side of the female adapter to the other end of the 3-inch pipe, and attach the 2-inch barrel to the narrow end of the 3- to 2-inch reducing connector.

3c. Let the cannon dry for several hours in a well-ventilated area before using. You don't want to fire it while the solvents are wet and flammable.

3d. Screw the 3-inch PVC end plug into the back of the chamber after drying.

How to Solvent Weld



1. Clean the weld surfaces with PVC primer. Apply the primer with a dauber or brush (usually inside the cap). The primer cleans and softens the PVC and allows the cement to penetrate the surface.



2. Brush on a thick coat of PVC solvent, first to the end of the pipe, and then to the fitting socket. Leave no bare spots.



3. Immediately join the pipe and the fitting socket, pushing the pipe to its full depth and making sure it's seated squarely with a slight twist. If you've used enough solvent cement, you should see a small, continuous ooze of cement around the fitting. Once joined, you can't reposition the pipes or otherwise fix errors. If you accidentally put the wrong fitting on a pipe, you need to trim it off and start over.

Photography by David Albertson

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4. WIRE THE IGNITION

4a. Test-fit butt connectors. Using a sharp utility knife, remove excess insulation from each crimp-on butt connector. With the stun gun turned off, test-fit the trimmed ends of the connectors over the gun's main electrodes. These are the twin electrodes that point forward, rather than toward each other, and we're hooking these up to our ignition wires, in order to bring the spark into the combustion chamber.

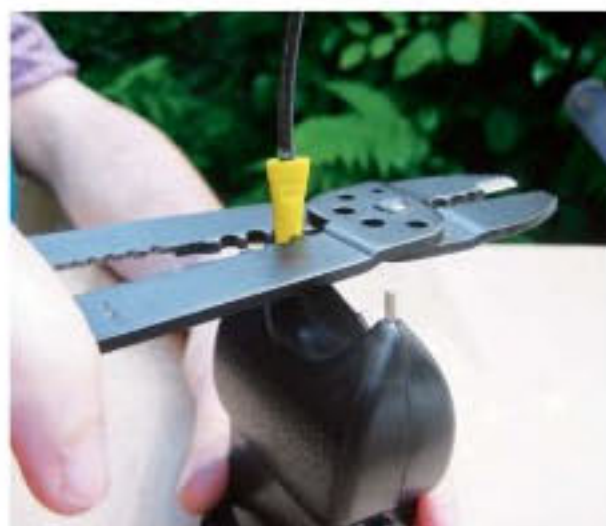


(Depending on the make and model of the stun gun, you may need to modify these directions and connect the wires in other ways, such as with wire nuts or soldering.)

4b. Prepare ignition wires. Cut the wire into two, 1-foot wires. These are the ignition wires. For each, attach a crimp-on spade to one end and the untrimmed end of a butt connector to the other end.



4c. Attach ignition wires to stun gun electrodes by crimping on the modified butt connectors.



4d. Cover the stun gun test leads (inboard electrodes) with wire nuts cut down to size, or other high-voltage insulators. Insulate all exposed metal areas of the ignition path on the stun gun and bolt electrodes, with electrical tape or silicone glue. It's easy for electricity to find its way underneath any insulation gap at the base of the electrodes.



Wire nuts need to be trimmed to fit onto the test electrodes.

5. ATTACH THE IGNITER

5a. Attach the stun gun body to the rear of the chamber using two hose clamps. Do not over-tighten. Position the stun gun body at a 90-degree angle to the axis of the electrode bolts.



5b. Attach ignition wires to electrode bolts, securing the spade connectors underneath the bolt head or between the nuts. You may have to bend the spades to widen them enough to fit around the bolt.



6. FINAL INSULATION

6a. Cover bolt connections with globs of silicone sealant. To further insulate, wrap the whole ignition area with bubble wrap, and tape down. The stun gun operates at such high voltage that the wrap still may not completely prevent shocks. Avoid contacting electrodes when operating the cannon. Don't be the path of least resistance!



Congratulations! Your Night Lighter 36 potato cannon is complete.



FINISH X

NOW GO USE IT >>