

Rocket Activity

High-Power Paper Rocket Launcher

Objective

Construct a launcher for use with the High-Power Paper Rocket activity.

Description

Using air pressure, large paper rockets can be launched to altitudes of between 50 and 100 meters. The launcher is a chamber in which air is pressurized with a bicycle pump or small electric compressor. Paper rockets are slipped over a launch rod tube. A lever-valve releases the air that propels the rocket. The launch rod can be tilted to various angles to launch vertically or horizontally. The launcher is easy to construct and requires few skills. The parts are available from a hardware or plumbing supply store and are inexpensive.

National Science Content Standards

Physical Science

- Position and motion of objects
- Motions and forces

Science and Technology

- Abilities of technological design

National Mathematics Content Standards

- Measurement

National Mathematics Process Standards

- Connections

Materials

Refer to the shopping list (see page 90)

Saw

Drill

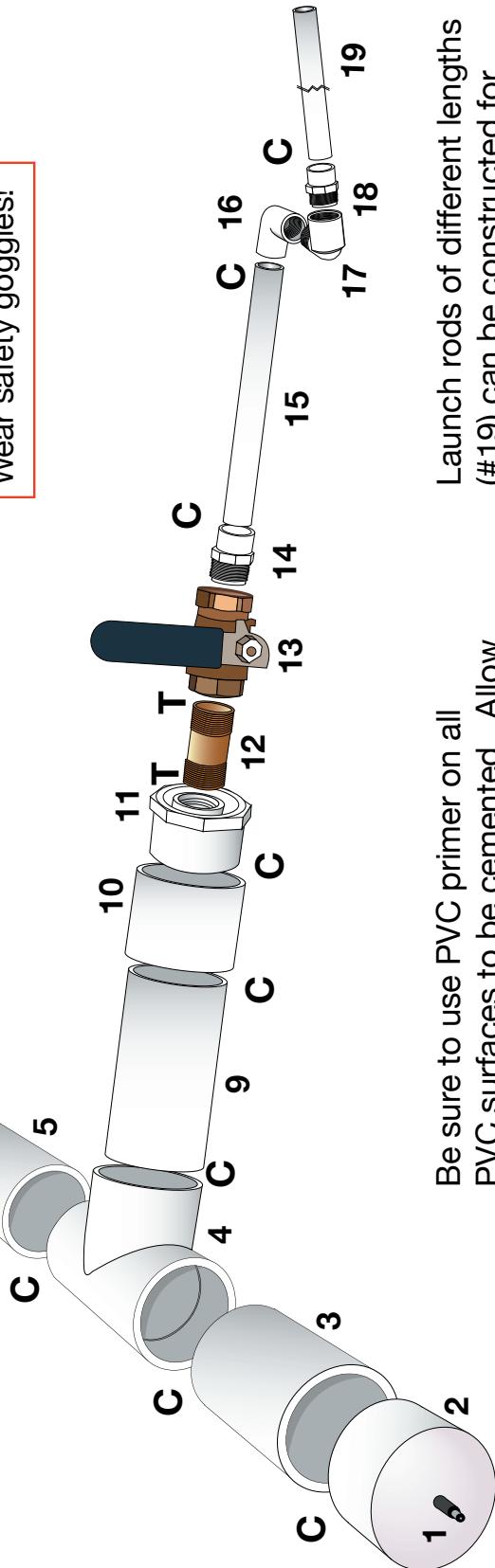
Bicycle pump or small electric compressor

Management

One launcher is sufficient for an entire class, and the launcher can be used year after year. The launcher is easy to construct and will take about 30-60 minutes to complete. Cementing the pieces is a quick operation, but the cement should be allowed to set overnight. When cementing, be sure to have adequate ventilation. A window fan blowing over the work area is advisable. Use eye protection when cutting pipe and cementing pieces.

High-Power Air Rocket Launcher Assembly Diagram

If you choose not to use a safety valve, replace these parts with a second cap (part #2).



Wear safety goggles!

Be sure to use PVC primer on all PVC surfaces to be cemented. Allow to dry before applying PVC cement.

Use adequate ventilation when cementing!

Numbers in the diagram are keyed to the parts on the shopping list.

Two parts #6 and 7 are required.

Places where parts must be cemented are indicated with a "C."

Places where metal threads should be sealed with Teflon tape are indicated with a "T."

Launch rods of different lengths (#19) can be constructed for launching short or long rockets. Cement the different rods into extra #18 parts and screw them into part #17 when needed.

If you do not have the tools to construct the launcher, a school volunteer should have them and may be willing to do the entire construction job for you.

The instructions include diagrams to make assembly of the parts easy. The assembly diagram below has numbers for each of the parts that are keyed to numbers on the shopping list. Take the shopping list to the hardware or plumbing supply store and the staff can help you select the parts. The 2-inch diameter tube may be available in a 5-foot length. You will need two or three of the 1/2-inch tubes. The tire valve can be obtained at an auto parts store. Select a valve with a long rubber-coated stem.

Assembly Instructions

1. Drill a hole in the center of one of the 2-inch caps (part #2). The hole should be just smaller than the diameter of the tire valve stem.
2. Remove the stem cap and jam the stem into the hole from the inside. Push it in as far as it goes. It is important to get a tight seal.
3. Cut the lengths of 2" pipe. Cut two pieces 8" long (parts #3, 5) and 1 piece 15" long (part #7). Clean the pipes and remove any burrs from the cutting process.
4. Cement parts #3 and 5 to the tee (part #4) as shown in the diagram. When cementing, the parts must first be primed with clear primer. This prepares the surfaces to be joined for bonding. Coat the surfaces that will be cemented. There is a brush inside the primer can lid. Let the primer dry before cementing. **Remember** to have adequate ventilation and wear eye protection!
5. Coat the primed surfaces with cement (ends of tubes and inside of the tee). There is a brush inside the cement can lid. **Quickly** shove the tubes into the tee as far as they go. Use a twisting motion for a better bond.
6. Repeat the cementing process with the 2" cap with the tire valve installed (part #2).
7. Cement the first 2" connector to the open end of piece #5. Cement the 2" to 3/4" flush bushing to the connector.
8. Install the safety valve into the flush bushing and seal it with Teflon tape. Do not use pipe joint compound. Be careful to align the threads so as not to strip the PVC threads.
9. Cement part #9 into the remaining opening of the tee.
10. Cement the remaining coupling (part #10) on to the end of part #9.
11. Cement the remaining 2" to 3/4" flush bushing into the open end of the coupling (part#10).
12. Thread the nipple into the threaded opening of part #10. Use Teflon tape to seal the threads to prevent air leaks.
13. Wrap tape on the other end of the nipple and attach the valve (part #13). The valve should be positioned so that when the lever is pulled down, it pulls towards the back (towards the tee).
14. Lightly screw part #14 into the other end of the valve. This part should not be sealed with tape. It is the beginning of the launch rod and can be removed for storage purposes.
15. Cement part #15 into the non-threaded end of part#14.
16. Cement part #16 on to the other end of the tube (part #15).
17. Join parts #16 and #17 by threading them together. Do not join them tightly.
18. Cement the ends of the three launch rods (part #19) into the three 1/2" to 1/2" adapters (part #18). Pick one of the launch rods and screw it into part #17.

After allowing time for the cement to set, the launcher is ready.

Notes

- The launcher can be used for many years. Store it in a cool place. Be careful not to drop it. The plastic will crack if treated roughly. If you notice any cracks, discard the launcher. The metal parts and the launch rod can be saved and used for a new launcher. **DO NOT** try to remove any pieces that have been cemented. If pieces are cemented improperly, discard them. The process of

removing cemented pieces will damage the pieces they were cemented to.

- When shopping, check the operation of the valve lever (part #10). Pick one that moves easily. A sluggish valve lever can be loosened by adding a few drops of lubricating oil to the shiny ball inside and working the valve several times.
- Part 16 and 17 permit tilting of the launch rod. Do not thread them together too tightly. A small amount of bar soap rubbed on the threads can help them move smoothly.
- Hardware stores carry shears for cutting up to 1"-diameter PVC pipe. They are optional but really nice to have available.
- Use some sandpaper or a file to bevel the open end of the launch rod to make it easier to slip paper rockets on to it.
- When using the launcher, have students practice pulling the lever. A slow pull will allow the air to slowly hiss out and not propel the rocket very far. A fast pull provides a whoosh and a great launch.
- Select a launch rod that best matches the size of the student rockets. Rockets made from a single piece of paper can be launched with a small rod. Use the longer rods for bigger rockets.
- If the launch rod is sticky or rough, smooth it out to reduce friction. A coat of wax rubbed on from an old candle makes a slick rod.

pressurize the launcher to 30 psi. This is sufficient for dramatic launches. If you have not included a safety valve, keep the pressure to under 50 psi to provide a wide safety factor.

6. When ready, have the student brace the launcher by pushing down on the tube (part #9) with one hand. The student should do a short countdown and pull the launch lever back quickly with the other hand. Launch!
7. Close the valve for the next student.



PVC Shears

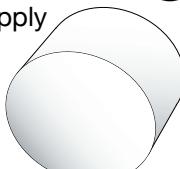
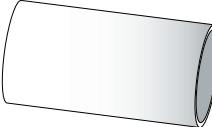
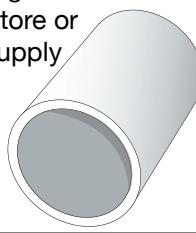
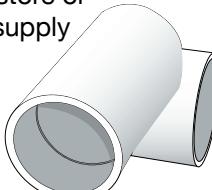
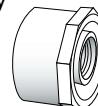
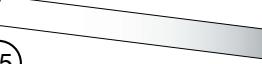


Tapered Launch Rod

Using the High-Power Launcher

1. Lay the launcher on the ground in a wide open space.
2. Attach the bicycle pump or small electric compressor.
3. Set up a clear area around the launcher. Have students not launching rockets stand back.
4. Have the first student put on safety goggles and slide his or her rocket over the launch rod. The rod can be tilted to any desired angle, but it should not be tilted to below 30 degrees. To aim the launcher in a different direction, pick up the launcher and move it.
5. Have the student work the pump to

Shopping List

<p>1 - Tire Valve (rubber stem) TR425 or similar Auto parts store</p>  <p>(1)</p>	<p>Pressure Operated Relief Valve (safety valve) (Wilkins) P1000A-50 Hardware store or plumbing supply (See note below.)</p>  <p>(8)</p>	<p>1 - 1/2" 90° Elbow (PVC) Slip and Thread Hardware store or plumbing supply</p>  <p>(16)</p>
<p>2 - 2" Caps (PVC) Slip Hardware store or plumbing supply (See note about pressure operated relief valve below)</p>  <p>(2, 6)</p>	<p>1 - 2" Pipe (PVC) 15" long Hardware store or plumbing supply</p>  <p>(9)</p>	<p>1 - 1/2" inch 90° Elbow (PVC) Thread and Thread Hardware store or plumbing supply</p>  <p>(17)</p>
<p>2 - 2" Pipe (PVC) 8 inches long Hardware store or plumbing supply</p>  <p>(3, 5)</p>	<p>1 - 3/4" Brass Nipple MIP X 2" Hardware store or plumbing supply</p>  <p>(12)</p>	<p>2 or 3 - 1/2" to 1/2" Adapter (PVC) Slip and Thread Hardware store or plumbing supply</p>  <p>(18)</p>
<p>1 - 2" Tee (PVC) Slip Hardware store or plumbing supply</p>  <p>(4)</p>	<p>1 - 3/4" Ball Valve Threaded ends Hardware store or plumbing supply</p>  <p>(13)</p>	<p>1 - 1/2" Pipe (PVC) 12", 24", 36" long Hardware store or plumbing supply</p>  <p>(19)</p> <p>Additional 1/2" Pipe (PVC) 24"-36" long (1 per student team)</p>
<p>2 - 2" Connectors (PVC) Slip Hardware store or plumbing supply</p>  <p>(6,10)</p>	<p>1 - 3/4" to 1/2" Adapter (PVC) Slip and Thread Hardware store or plumbing supply</p>  <p>(14)</p>	<p>1 - PVC (primer) and Cement (clear) Hardware store or plumbing supply</p> 
<p>2 - 2" to 3/4" Flush Bushing (PVC) Slip and Thread Hardware store or plumbing supply</p>  <p>(7,11)</p>	<p>1 - 1/2" (PVC) 12 inches long Hardware store or plumbing supply</p>  <p>(15)</p>	<p>Teflon Tape (Not plumber's joint compound!) Hardware store or plumbing supply</p> 

The Pressure Operated Relief Valve (also called Popoff Valve) is a recommended safety feature. The PVC pipe is rated at 280 PSI. The valve increases the safety factor by limiting the maximum pressure inside the launcher to 50 psi. This part, though inexpensive, may have to be special ordered.