BCC-Aerospace Program Technology Curriculum Resource Packet 2004

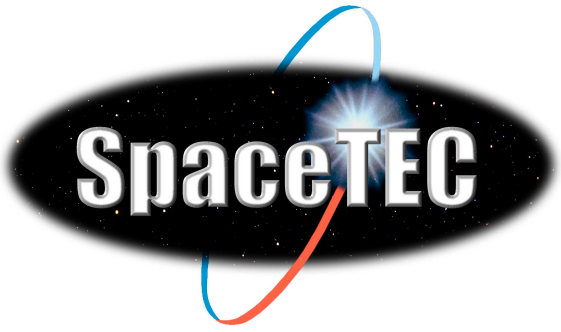

Table of Contents

FOREWORD

This resource packet was a follow-up to our previous year's resource packet developed out of our intitial groundbreaking partnership. The SpaceTEC National Center of Excellence is funded by a grant from the National Science Foundation. SpaceTEC, which is located at the Kennedy Space Center and managed by Brevard Community College (BCC), provided the catalyst for the development of this packet. Chartered to bring "Schools to Space" and "Space to Schools", SpaceTEC, in conjunction with the Aerospace Technology program at BCC, decided to explore this partnership with the NASA Education Office at the Kennedy Space Center. All three partners discovered how we could share and distribute space related curriculum into the local public schools.

The initial concept emerged from an Aerospace Technology Workshop that was sponsored by Brevard Community College in May 2003 in cooperation with the NASA Education Office at the Kennedy Space Center. Approximately twenty Brevard County math, science, and technology teachers participated in a two-day session where they were introduced to aerospace related experiments and took part in aerospace technology-based seminars. From this program, two very excited technology teachers agreed to partner with BCC, SpaceTEC, and the NASA Education Office to assist with the compilation and development of these technology related experiments. Hence, our first resource packet.

The following year, 2004, SpaceTEC, BCC, the Brevard County School District, and the Florida Space Research Institute (FSRI) partnered to provide a high-powered rocket workshop. At the same time, SpaceTEC and BCC sponsored a teacher for the Summer Industrial Fellowship for Teachers (SIFT) program. The SIFT teacher was inspired through working with the aerospace program and with the rocket workshop to begin developing a way to compile numerous aspects of air-powered rocketry. Using ideas he was currently using in his classroom and adding new ideas from different sources, he was able to compile a very comprehensive guide to air-powered rocketry. Very safe, exciting, and an extremely easy and inexpensive way to get students (as well as teachers and adults) excited about rocketry and space.

This was a superb and forward thinking effort that began as a workshop and ended as an excellent resource to assist teachers in adding space-related subjects to their curriculum. We tried to encapsulate all of the acknowledgements and special thanks at the end of this booklet. Hopefully we included everyone that was involved. We only hope this is one of many multi-agency partnerships that will continue to bring "Schools to Space" and "Space to Schools".

George Daniel Strohm
Associate Director
BCC Aerospace Programs

IT'S NOT ROCKET SCIENCE

It's 100% Pure Fun!

The complete guide to air powered model rockets plus more!

What middle school students love to do!

By Jess Heller
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Overview:

This manual is intended to be a starting point that will open the doors to endless possibilities only limited by your imagination. The grade level is targeted to middle school students but can be adapted for high school students. Not every detail is included in this manual. I left room for adjustments due to substitution of parts and the availability of supplies.

Students construct paper rockets and launch them with an air pressure rocket launcher. Using simple sighting devices, along with basic trigonometry and algebra, the altitude the rockets reach can be determined.

National Education Standards

Science

Unifying Concepts
- Change, constancy, and measurement

Physical Sciences
- Motions and Forces
- Transfer of energy

Science and Technology
- Abilities of technological design

Mathematics

Patterns, functions, and algebra
Geometry and Spatial Sense
Measurement
Data analysis, statistics, and probability

Technology Education

Design
- Engineering design
- Troubleshooting, R&D, invention
- Innovation and experimentation

Abilities for a Technological World
- Apply the design process

The Designed World
- Energy and power technologies
- Transportation technologies
- Manufacturing technologies
- Construction techniques

The first rocket launcher is the simplest to construct and least expensive. It's completely manual, but it can be altered to a more advanced version at a later time.

The main unit is made out of PVC pipe. The parts can be purchased at any home center. Mine were bought at Lowe's. Some parts were bought at Wal-Mart.

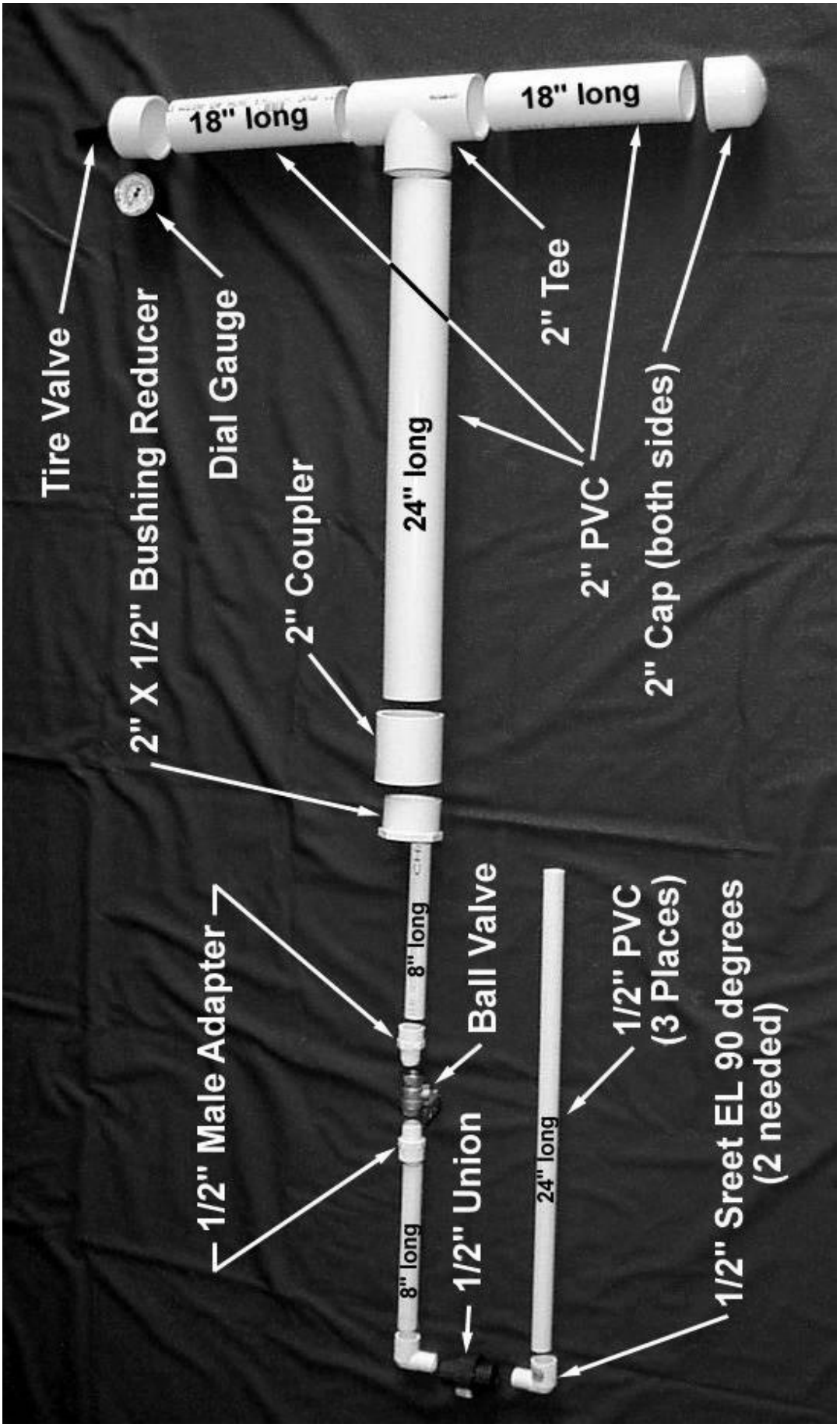
LAUNCHER PARTS LIST

ITEM	NUMBER	DESCRIPTION	LOWE'S ITEM NUMBER	WAL-MART UPC NUMBER	PRICE	TOTAL
1	1	1/2 in Schedule 40 PVC - 5 ft.	23967		$0.78	$0.78
2	1	2 in Schedule 40 PVC - 5 ft.	23833		$3.74	$3.74
3	2	1/2 in male adapter PVC	23855		$0.18	$0.36
4	2	1/2 in Street EL 90 deg. PVC	22678		$0.48	$0.96
5	2	2 in Cap – PVC	23900		$0.88	$1.76
6	1	2 in Tee – PVC	23908		$1.34	$1.34
7	1	2 in Coupling – PVC	23902		$0.71	$0.71
8	1	2 x 1/2 in Bushing Reducer- PVC	22910		$0.76	$0.76
9	1	1/2 in Union	23476		$1.68	$1.68
10	1	1/2 in Threaded Ball Valve	21519		4.58	$4.58
11	1	2 in Dial Gauge (0 - 160 psi) 1/4 in NPT	221022/13		$8.75	$8.75
12	1	Bicycle Pump		3501185092	$6.96	$6.96
13	1	Tubeless Tire Schrader Valve - .453		7723104180	$1.97	$1.97
		GRAND TOTAL				$34.35*

*Please note that prices may change.

The PVC parts are fitted together and cemented with PVC cement.
The threaded pieces should be wrapped with 3 layers of Teflon tape.
These items can be bought at any home supply store.

*If the air pump you are using has a pressure gauge, you do not need to buy and install another one for the launcher.



Launcher Parts Layout

Materials needed to build a paper rocket

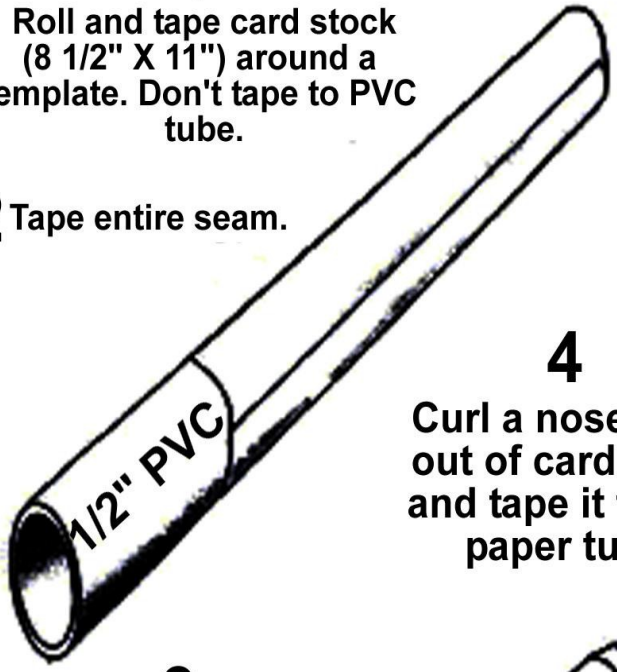
8 1/2” X 11” Colored Cardstock
Cellophane Tape
Scissors
Ruler
Pencil
Rocket forms ½” PVC approx. 12” long
Launcher
Electric air compressor or hand pump w/locking air chuck
Safety glasses for launch

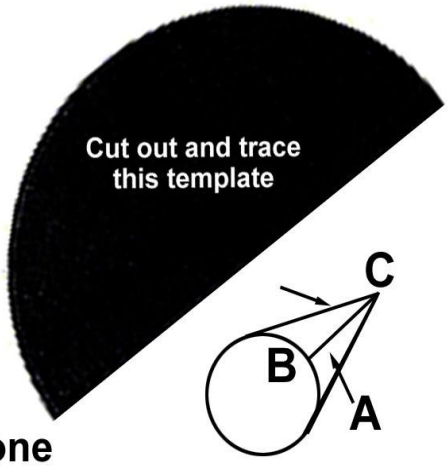
Optional:
Duct tape
Markers
Altitude tracker

Making the Rocket

1
Roll and tape card stock (8 1/2" X 11") around a template. Don't tape to PVC tube.

2 Tape entire seam.

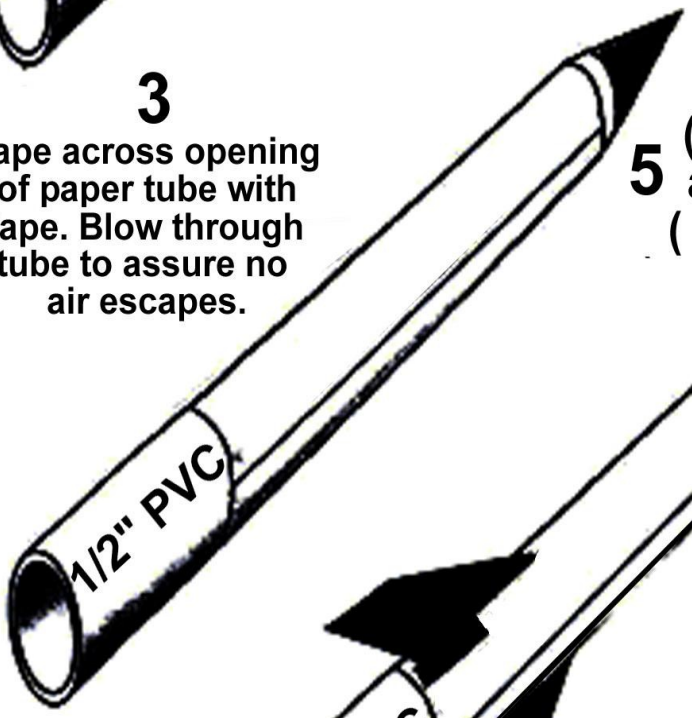




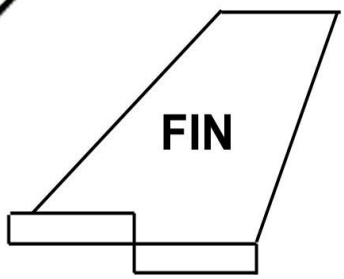
4
Curl a nose cone out of card stock and tape it to the paper tube.

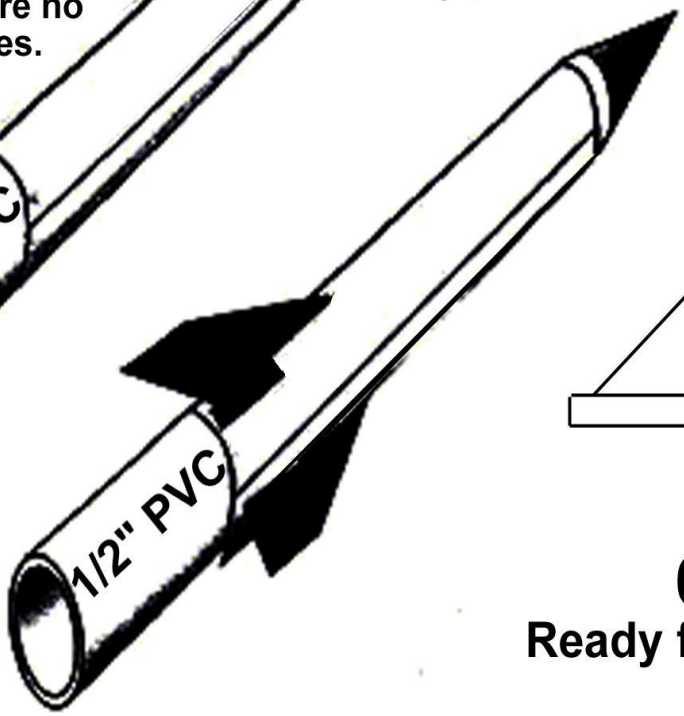
Nose cone pattern
Curl "B" under "A" so that "C" becomes the point.

3
Tape across opening of paper tube with tape. Blow through tube to assure no air escapes.



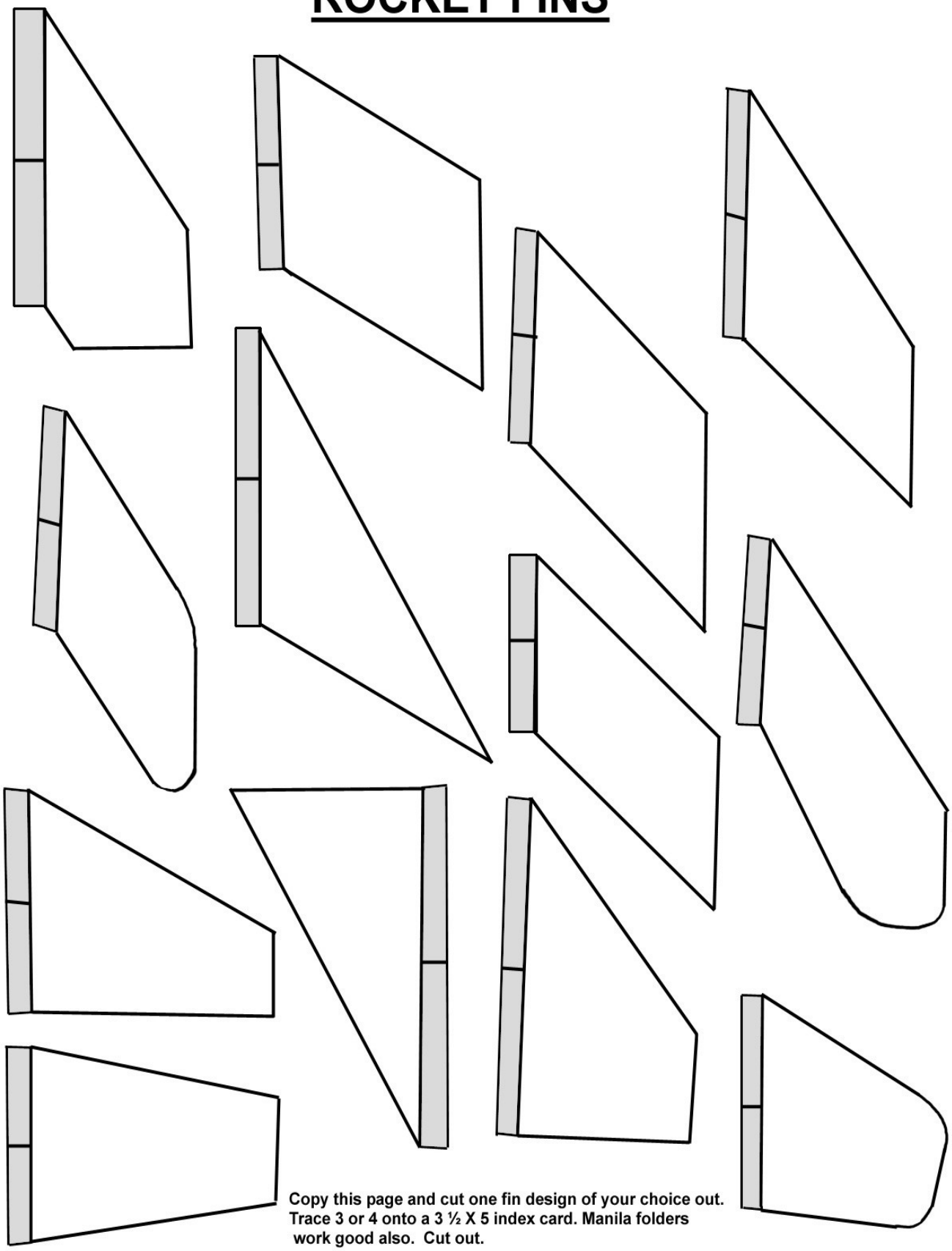
5 Attach 3 or 4 fins (cut from card stock) and attach to rocket. (See fin design sheet)





6
Ready for Flight

ROCKET FINS



Copy this page and cut one fin design of your choice out. Trace 3 or 4 onto a 3 ½ X 5 index card. Manila folders work good also. Cut out.

Rocket Construction

Use the instruction sheet for constructing the paper rockets. Have your students roll paper around the 1/2" PVC tube. The tubes serve as forms or templates for constructing the rockets. For best performance, the paper should be snug on the form but able to slide easily. Make sure students firmly attach the fins and nose cone for their rockets. Poorly attached nose cones will blow off the rocket, leaving the rocket behind. Poorly made rocket bodies may explode into confetti while on the launch pad.

Tips for making rockets:
Do not wrap the paper around the ½" PVC too tight.
The rocket launcher is the same diameter and has to move off freely.

One end of the rocket needs to be closed off completely so no air escapes when you blow through the tube. Use at least four strips of cellophane tape in a criss cross pattern. (Duct tape can be used for this job but it is bulkier)

You can mash down one end of the rocket body about ½ inch as if you were rolling up and sealing a roll of coins. Then add your tape.

Leave in PVC tube in throughout all the steps to avoid rocket tube from collapsing. Especially when putting the fins on.

This project usually takes 2 days including decorating. Don't rush!
Decorating and customizing the rocket with colored markers, pens or pencils can be fun. Don't forget to have students put their names and class on the rocket.

Launch Procedures

Follow the instructions for constructing paper rockets. When the rockets are ready, follow these instructions for the launch.

1. Select a clear field for the launch. Although the rockets are made of paper, they can still cause injury if someone is struck by them.

2. Connect the air compressor or hand pump to the tire valve on the launcher. Put on safety glasses. With the valve closed, pump the launcher up to 60 pounds of pressure. DO NOT LET STUDENTS PUMP OVER 60 POUNDS. You can practice ahead of time with lower pressure to determine whether or not you will need the full 60 psi.

3. Set up the launcher and orient the base so that the launch tube is between 30° and 45°. This launch will go for distance. Set up the launcher and orient the base so that the launch tube is set between 70° and 80°. This launch will go for height. NEVER LAUNCH AT 90° (Straight up). To practice safety and to be fair, have students retrieve their rockets after the last student has launched.

4. Load the rocket on the launch rod. Clear the landing, site from bystanders

5. Perform a count down. If you will be determining how high the rocket flies, the count down lets trackers know when the rocket is about to launch.

6. Make adjustments to the aiming as students launch their rockets.

7. Launch all the rockets before you allow the students to retrieve them.

Tips:
To make it easier to slip rockets on to the launch tube, a file or sandpaper maybe used to taper the upper end of the launch tube.

Some teachers have reported better flight performance with low-pressure launches than with high-pressure launches. Aerodynamic drag on the rocket increases with velocity. At higher initial velocities, rocket fins may be distorted, leading to even greater drag and diminished performance.

At least one rocket will experience fin and or nose cone problems during launch. Be sure the teacher brings a roll of scotch tape, duct tape and super glue for quick on-site repairs.

SAFETY TIPS

1) Always launch in a flat area, free of trees, bushes, electrical lines and low flying aircraft. The bigger the area, the easier it is to recover your rockets. Fly only on clear days with little or no wind.

2) Before launching, pay attention to the direction of the breeze (if any) and place your launcher so that, even if the wind carries the rocket 10 or 15 meters (30 to 45 feet) away, it should still land in a clear area.

3) Do not pump the launcher up to a pressure greater than ½ the rated pressure of the weakest part. The PVC pipes and the valve come with pressure ratings. If the lowest rating is 150 psi, do not pressurize the launcher greater than 75 psi. This provides a significant safety margin.

4) Be careful in handling the launcher. PVC can crack if dropped or struck with sufficient force. Inspect the launcher before use. Discard or repair a launcher that shows signs of cracking.

5) Do not lean over the launch rod at any time

6) Do not place anything inside the launch tube.

Alternate Indoor Rocket Design

I like to introduce paper rockets to students with the construction of an indoor rocket first. This rocket is thinner and can be launched inside. The launcher needs an adapter to fit a thinner rocket. (See next page)

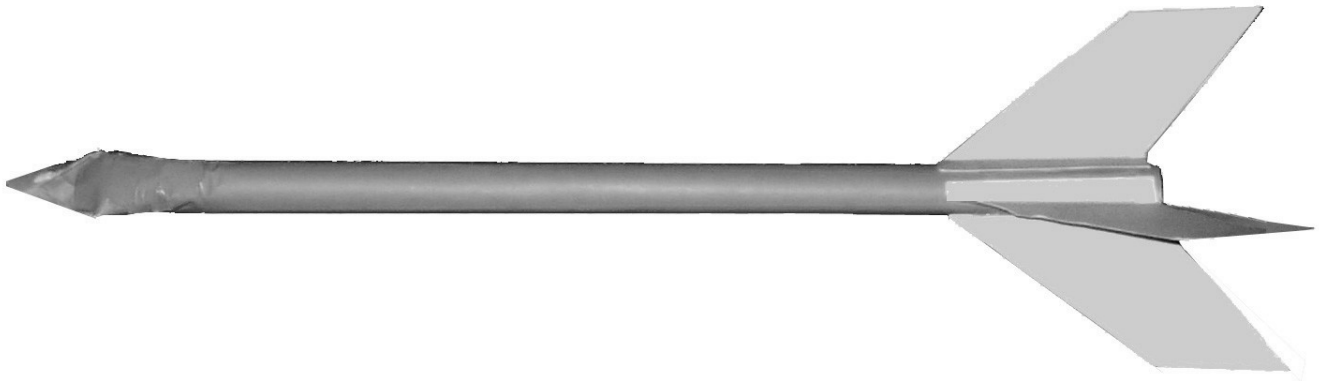
Supplies needed:
Colored 8 ½" X 11" paper (I use #20 fluorescent color paper).
Cellophane Tape
Scissors
Ruler
Pencil
Rocket forms 7/16" Wood dowel approx. 12" long

Rocket Construction:
This rocket is made the same way as the bigger rocket is made except for:

The colored paper is cut in half to produce 2 – 4 ¼" X 11 sheets. (One half sheet per rocket)

The paper is rolled tightly and taped in the same manner as the larger rocket.

A separate nose cone is not needed. The tip is flattened and the sides are folded in to form a point and taped closed. Make sure no air escapes when you blow through.

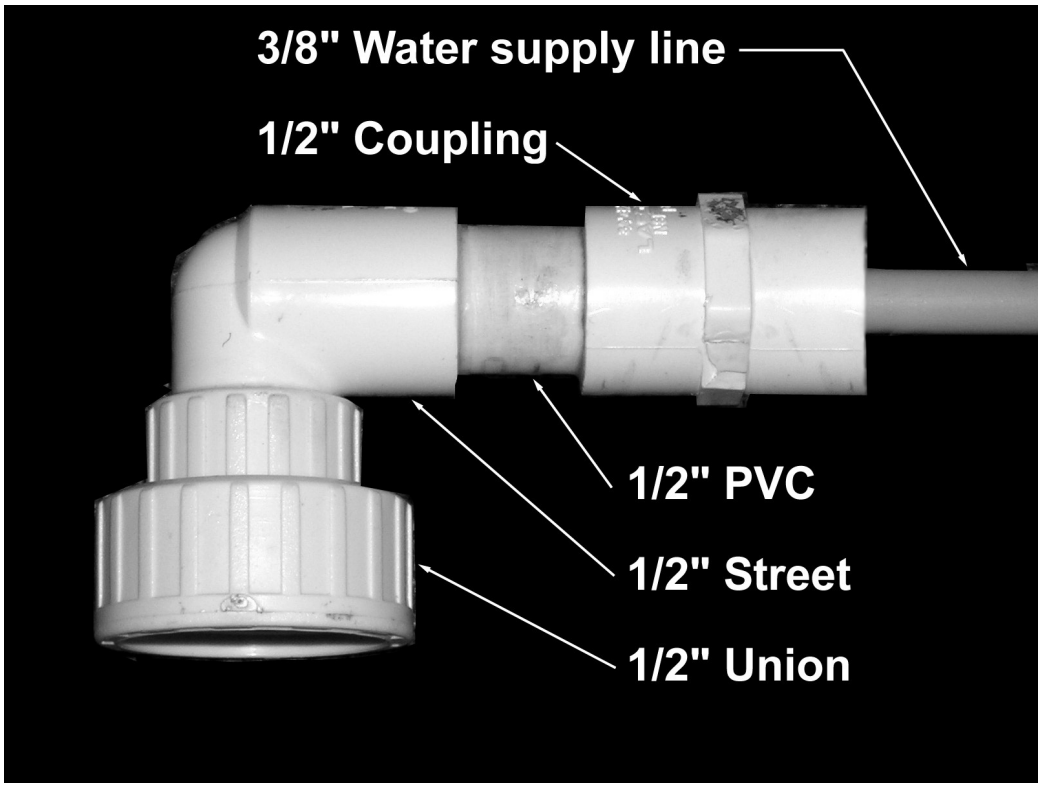


Parts list for the adapter to launch smaller rockets

1/2” Coupling - PVC
1/2” Union - PVC
1/2” PVC – 2”
1/2” Street EL 90° - PVC
3/8” X 15” plastic water supply line

Construction of the adapter

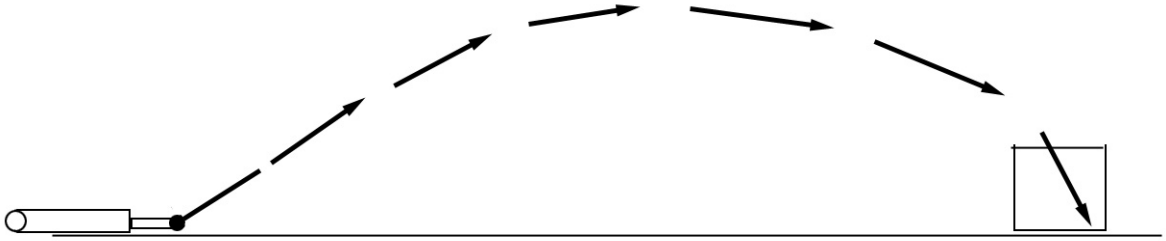
- Place the coupler over the water supply line.
- Cement the 2” long PVC X 1/2” PVC pipe to the coupler locking the water supply line in between. (You may need to sand or file the end of the water supply line down so it can fit sandwiched between the pipe and the coupler).
- Cement ½” Street EL 90° to the other end of the 2” long X 1/2” PVC pipe.
- Cement the larger side of the union onto the 1/2” Street EL 90° - PVC



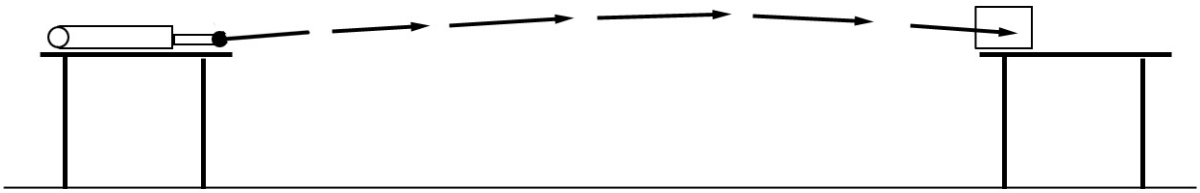
Suggested Launches for Indoor Rockets

Two days can be used launching.

1. Setup a box across the room and have students try to lob their rockets into it. Start with 15 lbs of air pressure.



2. Setup 2 tables and place a small waste basket on its side with the open end facing the launcher. A bull's-eye can be placed inside for a visual effect. Start with 20 lbs of air pressure. Place the launcher on the other table.



Launcher Button Modification Option

Instead of using the ball valve, which can sometimes be awkward, a solenoid and button can take its place. It's easier to use and gives the user an equal burst of air. Students love the ease of operation and it is fun too.

In order to upgrade your launcher it will require additional work and added cost. Make sure it is worth your while. A new launcher can be built or modify your existing one.

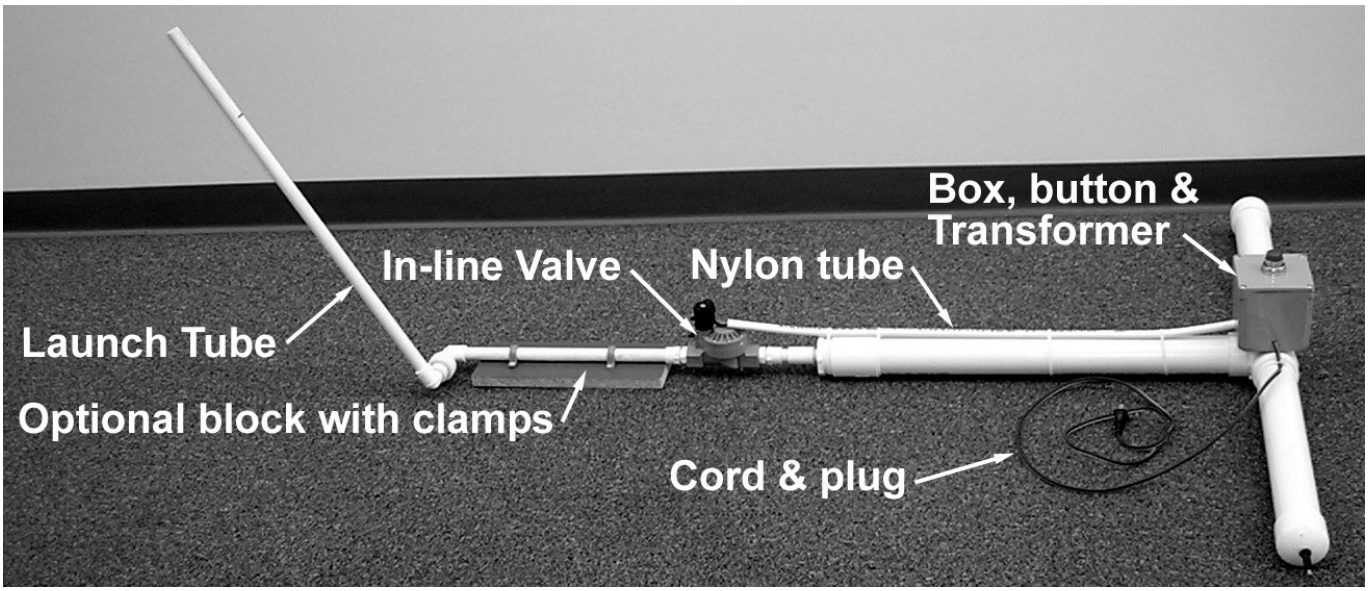
Supply list for button modification

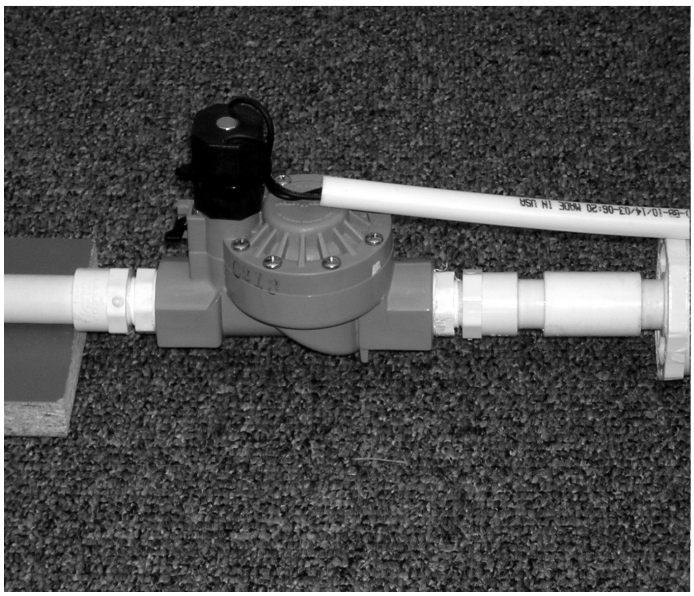
ITEM	NUMBER	DESCRIPTION	LOWE'S ITEM NUMBER	RADIO SHACK NUMBER	PRICE	TOTAL
1	1	In-Line Irrigation Valve	50161		$11.41	$11.41
2	1	1/2 in Union	23476		$1.68	$1.68
3	2	3/4 X 1/2 MXF Bushing PVC	51275		$0.53	$1.06
4	1	Pex Pipe 3/8 X 5'	68405		$1.78	$1.78
5	1	4X4X4 electrical box	10029		$8.71	$8.71
6	1	Transformer		273-1366	$6.96	$6.96
7	1	Door bell Button*	78592		$3.97	$3.97
8	1	1/2 in Street EL 90 deg. PVC	22678		$0.48	$0.96

In addition to the above you will also need 3 large tie wraps, wire nuts, screws, nuts, 90+ inches of lamp cord and plug, and electrical tape.

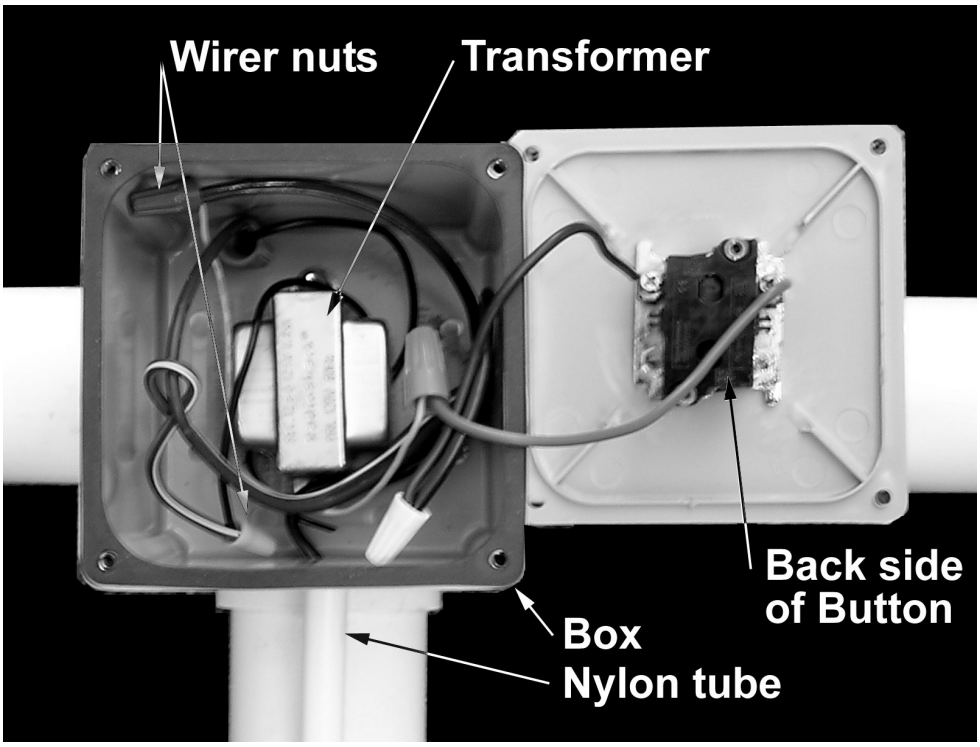
* The button called out for is a door bell button. A larger button is preferred (as illustrated). It can get costly and the home centers do not carry them. Check with Grainger or any electrical hardware supplier and look for a momentary button.

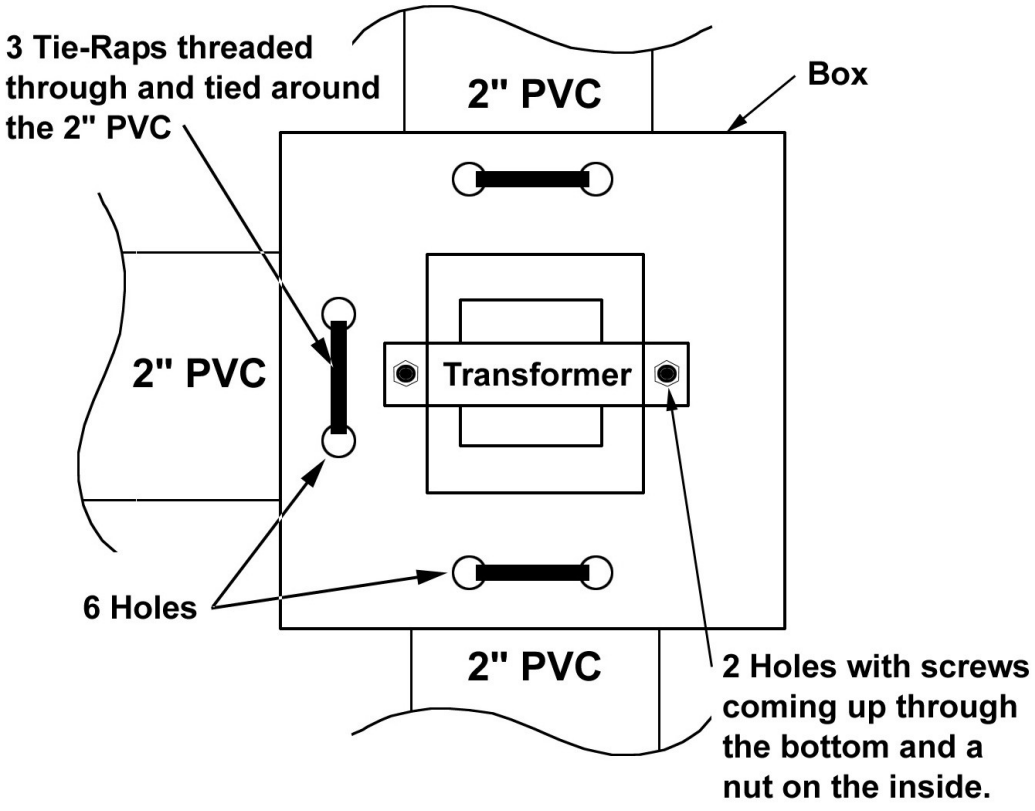
Button Launcher Layout



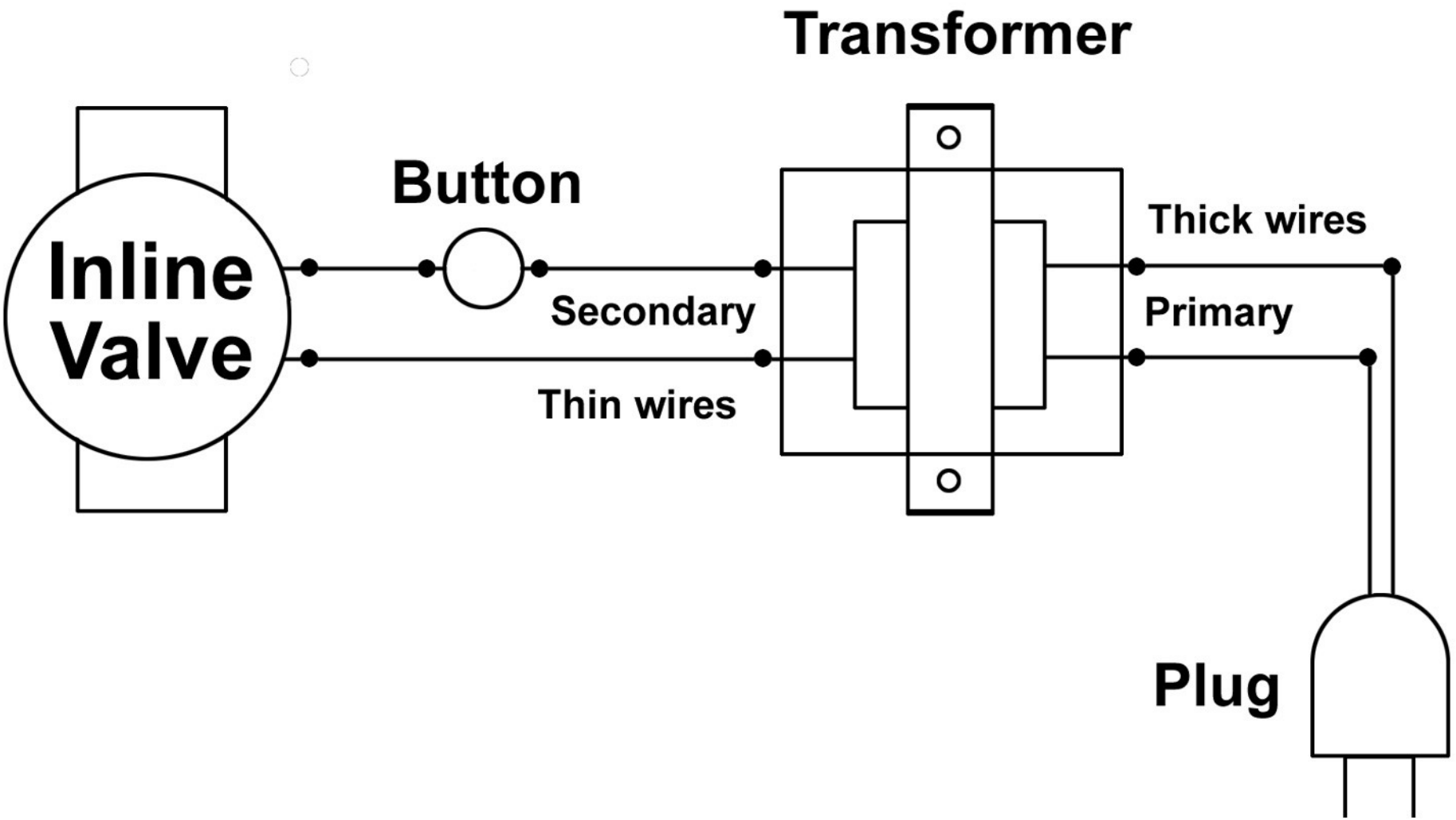


Button Launcher Diagrams



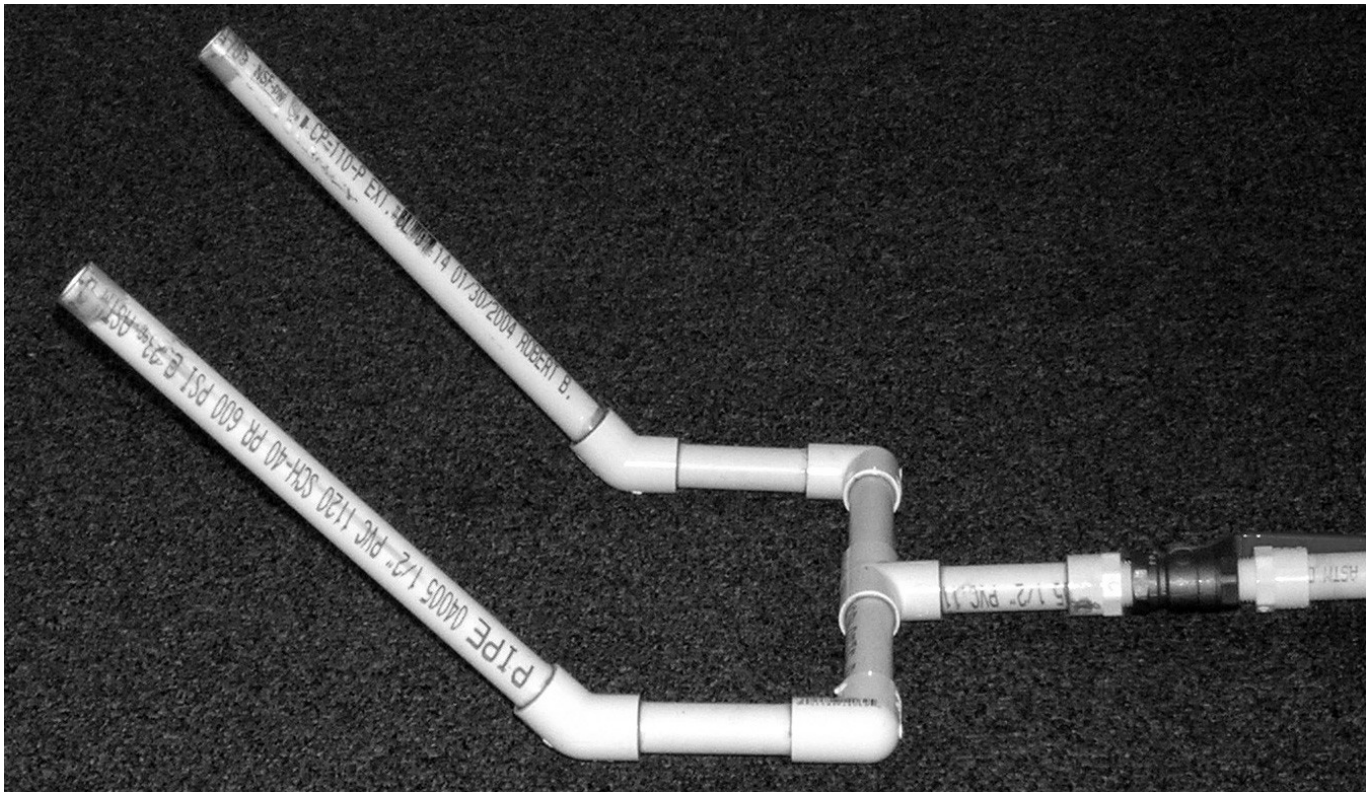


WIRING DIAGRAM



Dual Rocket Launcher

Two rockets can be launched simultaneously with the construction of another adapter.



A new union can be used or the dual launch adapter can be screwed directly into the valve without a union.

Parts needed for a Dual Launcher

½” PVC
1- ½” Tee
2- ½” 45°
2- ½” 90°
1- ½” male adapter

Rockets do not go as far when launched together. The air is equally divided to both rockets. This is a good way to have students compete against each other.

Rocket Cars

Another use for the rocket launcher takes us out of the sky and down to the ground. This is a type of CO_2 car without the CO_2 cartridge and launchers.

CO_2 car launchers are expensive to run and some fail at times. Students usually want to launch again and failed launches can get expensive. With this system, cars can be launched over and over again at no cost.

Students will need access to woodworking equipment and/or hand tools.

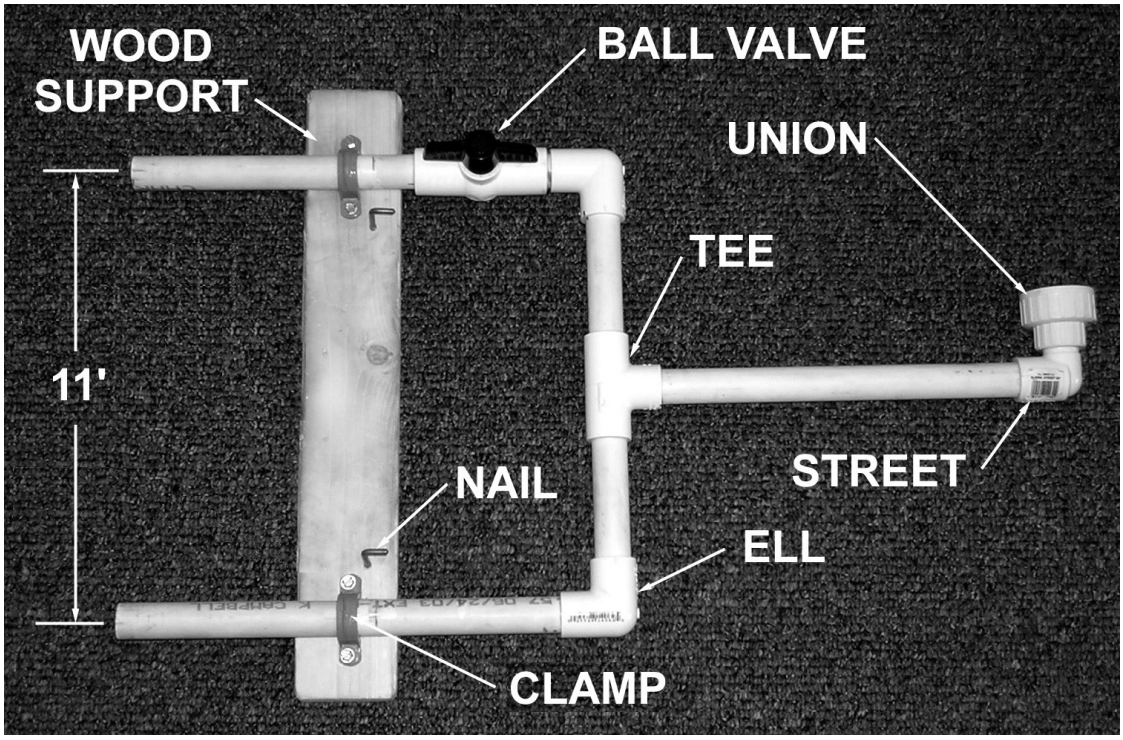
The set up and construction requires a launch end and a receiving end connected by two rows of 50 lb. fishing line.

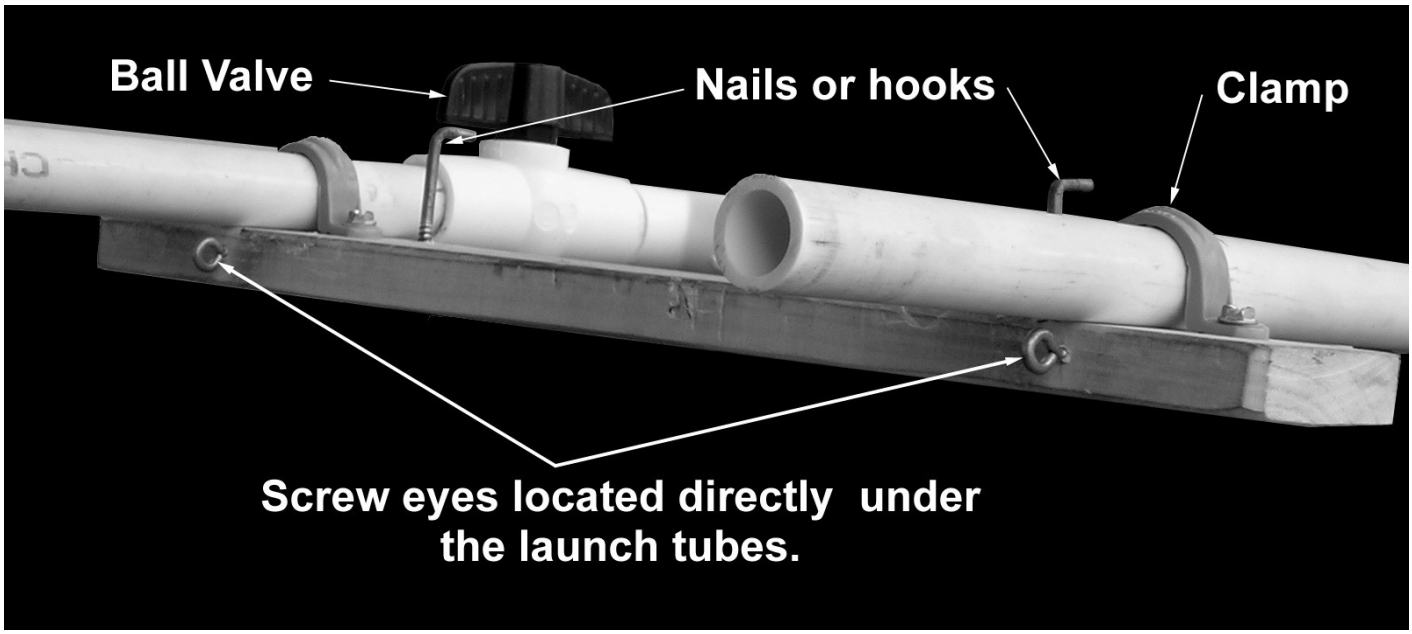
Supply list for rocket car launcher modification

ITEM	NUMBER	DESCRIPTION	LOWE'S ITEM NUMBER	PRICE	TOTAL
1	1	1/2 in Union	23476	$1.68	$1.68
2	1	1/2 in TEE	23873	$ .18	$ .18
3	2	1/2 in ELL	23867	$ .16	$ .16
4	1	1/2 in Street EL 90 deg. PVC	22678	$0.48	$0.48
5	1	1/2 in Ball Valve	21484	$1.93	$1.93
6	1	20 in X 14 in. Plywood			
7	1	28 in X 2 X 4			
8	1	15 X 3 X 1/2 wood			

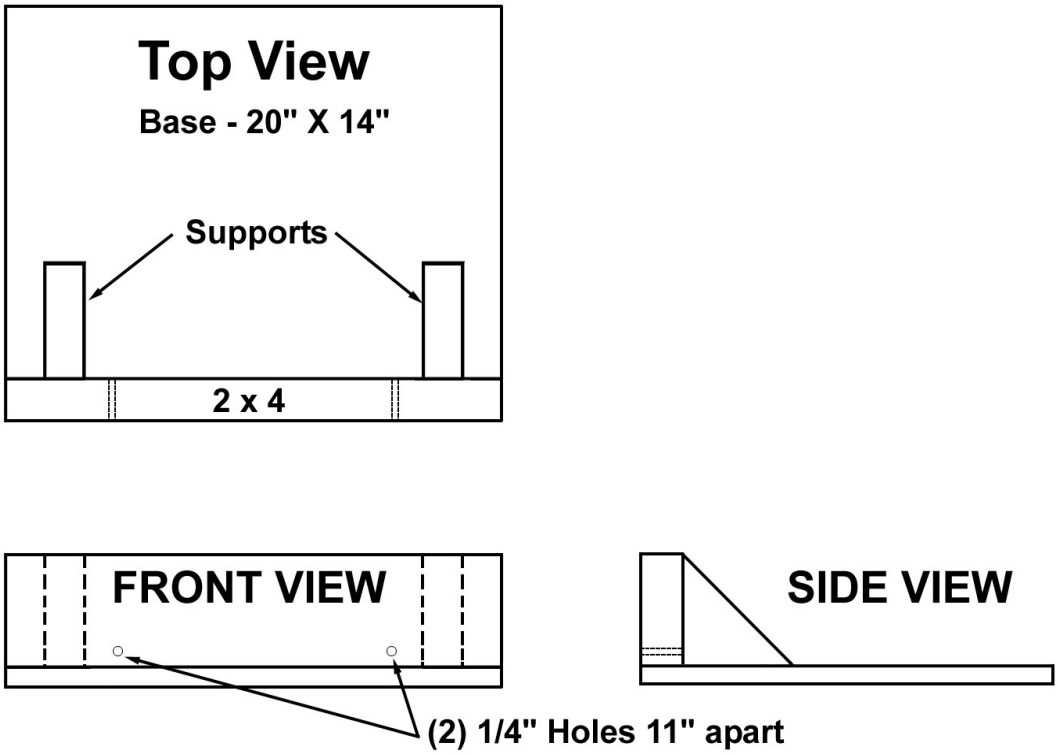
In addition to the above you will also need white glue, screw eyes, nails, ½" PVC clamps, 50# fishing line and #4 leader sleeves.

Launch End





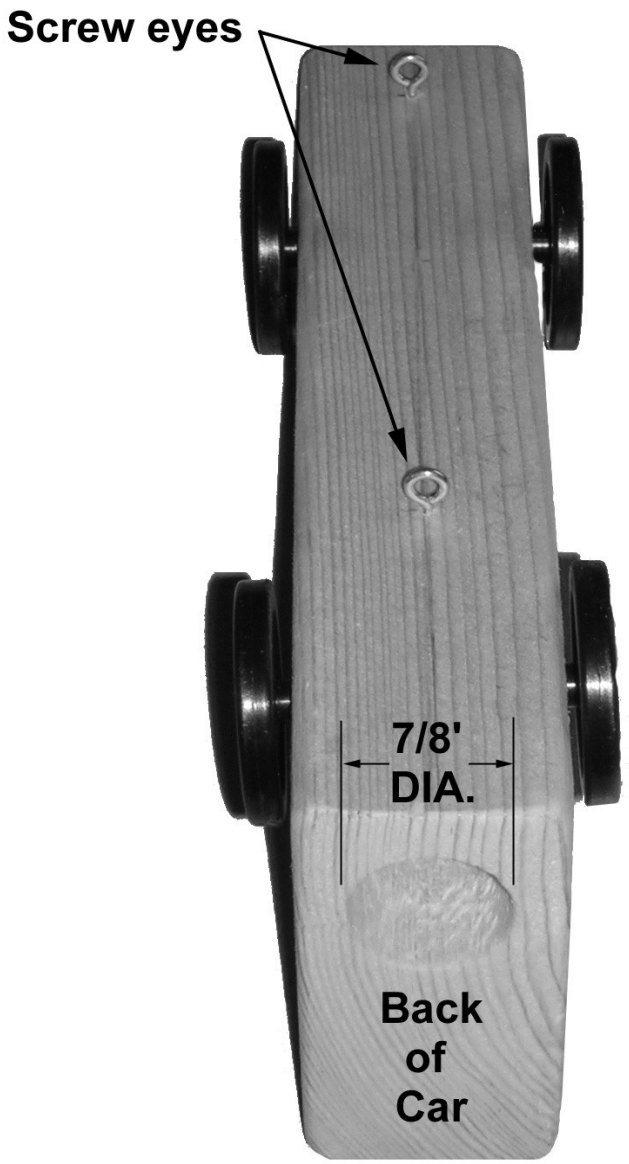
Receiving End



Constructing the Car

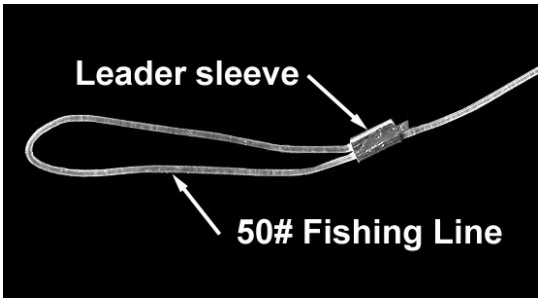
The car is limited by the tools and equipment available. It starts off with a 6” or 7” block of 2 X 4 (can be longer if you choose). The wheels, axles and screw eyes are purchased from Pitsco. A catalog can be ordered from www.pitsco.com or 1-800-835-0686. There are many wheel styles to choose from. Make sure you order axles and 2 screw eyes for every car. Once you draw a plan, build a prototype. After your car launcher is built, you can then locate the height of the rear hole. Make sure you do this with the wheel on the car flat on the ground. The size of the hole is 7/8” and is best made on the drill press in a vice with a spade bit. The depth of the hole is determined by the location of the rear wheel axle. The car will launch with a 1” deep hole but will go faster with a deeper hole. Two screw eyes are installed on the bottom of the car along the center line. They are needed to guide the car straight down the track.

Bottom View of Car



Setting up the launcher and launching the car

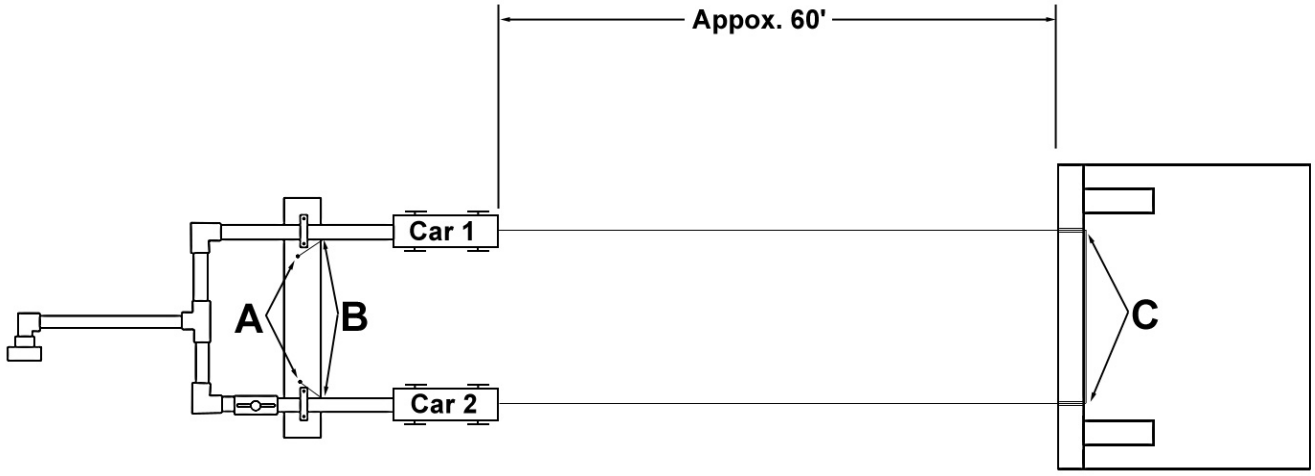
Set up the launcher and approximately 60’ away place the wooden receiving end.
Make a 1” loop at the end of the fishing line and thread on a leader sleeve as shown.
The leader sleeve can be clamped in place with pliers or hammered closed.



Thread the looped end through the front of hole “C” on the wooden receiver (see illustration). Continue threading the loop through the backside of the other hole “C” heading back to the launcher. Hook the loop onto the launcher and even up the fishing line. Cut the fishing line back at the launcher. You should have approximately 120’ (2 sections of 60’) of fishing line exposed. Make another loop using a leader sleeve and hook onto the launcher.

Thread one loop through the front screw eye on the bottom of car from front to back. Continue threading through second screw eye. Thread through “B” screw eye from outside to inside on the launcher (see illustration). Hook on nail “A”. Repeat for other side.

Note: If one car is to be launched, shut the ball valve and use the opposite side.



Place a rolled up towel on the floor in front of the receiver to protect cars from hitting the front of the receiver.

While placing cars on the track you should have slack in the line. Once attached and ready for launch, have a student stand or kneel on the receiver and tighten the lines. The tighter the lines are pulled the better the cars will run.

IMPORTANT: NO MORE THAN 70 LBS OF AIR SHOULD BE USED.

If cars fall on their sides after launching, have a student place one foot on the wooden part of the launcher. After launch, the lines should still be pulled tight and the cars sent back to the launcher.

Special Thanks and Acknowledgment

Jesse Heller, Technology Teacher, Jackson Middle School

Peri-Baker Horner, Instructional Design Specialist, BCC Aerospace Program

Damon Talley, Education Information Specialist, KSC Educators Resource Center

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