St. Martin of Tours IMS

2017 Engineering Notebook

SMTperch

"We are better together"

SMT SeaPerch

St. Martin of Tours School

Independence Mission Schools

Mr. Andrew Bevilacqua, Mr. Scott Jackson and
Mr. Charles Pavonarius

5701 Loretto Ave.

Philadelphia, PA 19124

(215) 535-2962

Table of Contents

List of References

[1] Learning Module "Buoyancy for Middle School"

[2] Learning Module "Vectors Middle School Content Brief"

[3] Video 3D Shapes: Maximizing Volume Video

[4] Video "Parabolic Flight - Lesson 1 Parabolic Motion Video"

[5] Displacement, http://www.middleschoolchemistry.com/multimedia/chapter3/lesson2

[6] Lecture by Timothy Kaiser

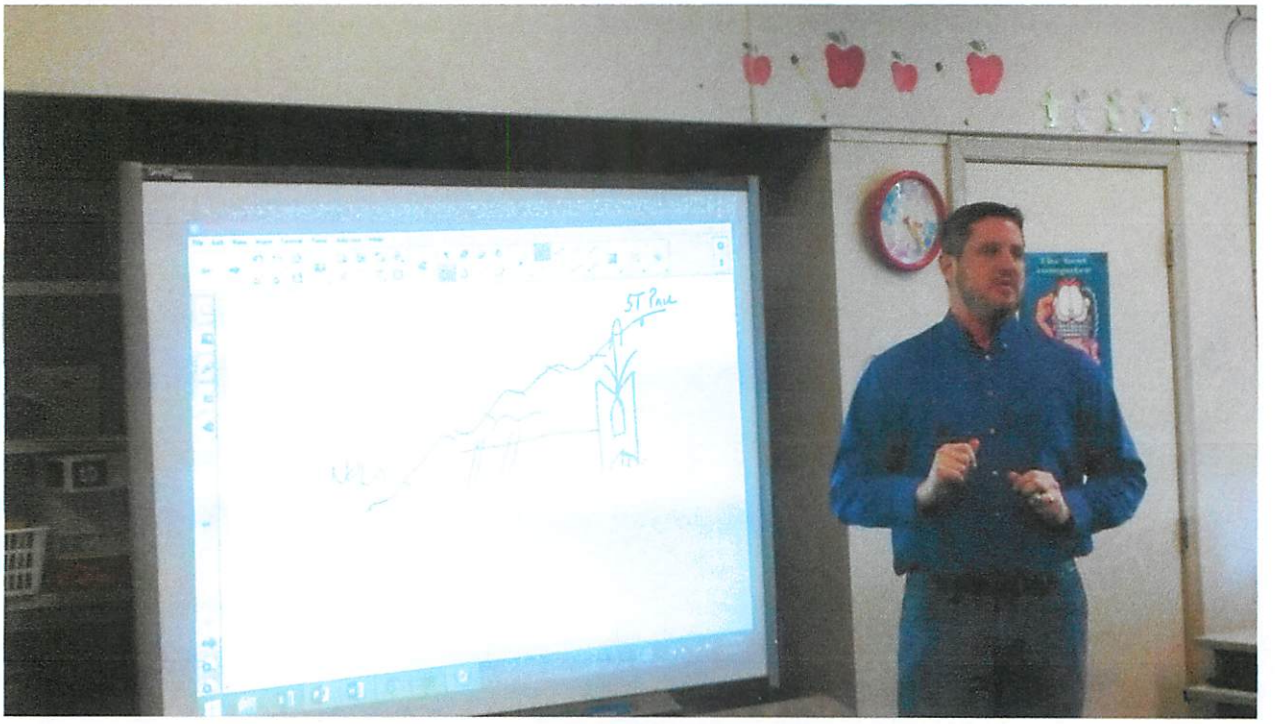
[7] Weight of PVC, https://flexpvc.com/Reference/PVCPipeSpecsRigid.shtml

Naval Engineering Research

With most of our team returning we used the knowledge we gained last year and applied it to this year's perch. Some of the terms that we learned this year were ballast and the center of gravity. Ballast is the act of giving stability to a ship or vessel by adding a heavy object to said vessel. The center of gravity is the point where the perch is balanced and the weight is equal on the starboard to the port and the bow to the stern.

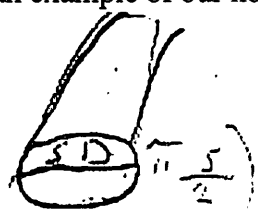
This year we used many learning modules. We used buoyancy[1] in our perch by adding motors and pool noodles. We also used vectors[2] when we decided where to aim our motors in order to move in a specific direction. Electrical circuits were used in the control box whenever we moved or hit a joystick. Every part of the perch was a 3D shape[3], which we experimented with often. All this year we have been preparing to battle against the parabolic motion[4] on the day of the competition.

We learned from our engineer that there are different schedules for PVC, we use schedule 40. Schedule 20 is less durable while schedule 80 has thicker walls and is heavier. This is important for determining how to balance the Perch. We also discussed displacement[5]. Anything that is in the water has to displace a certain amount of water and water is heavy! A cubic foot of water weighs 62.4 pounds (28.3 kg)[6]. Some of us weigh less than two cubic feet of water.



Example of Research and Calculations

Our mentor, Timothy Kaiser from the Army Corps of Engineers, discussed displacement and the weight of the PVC. Here is an example of our notes and calculations[5, 6, 7].



$\pi r^2 l$

$62.4 lb/ft^3$

displacing Volume = 62.4

Get an estimate Balance natural Buoyancy
Volume of motors

Floats

Legs 5" x 4
Bottom 12" x 2
Top 9" x 2
Cross 7" x 3
Arm 6" x 1
Fingers 4" x 2

97"

O = 0.840 R 0.42
D = 0.622 R = 3" $\pi r^2 l$

53.73 in³

wall thickness Aka the schedule 29.46 in

24.27

12 x 12 x 2

0.876 lbs

Pipeline repair Underwater mission

Design and Engineering Process

We worked very well as a team to help us get to the final product. Then to get to the final product we had to think of modifications. Individually, we drew and discussed modifications. The first idea was a standard perch with an S hook attached to the netting at the top but it wouldn't be useful for the other challenge.

We then came up with a new idea, the idea was to add a PVC extension to pull the hoop on the mousetrap challenge. We learned from last year that our sea perch wouldn't go deep enough so we decided to buy washers so we can equip it just in case. We used the engineering theories of buoyancy, integrity, and maintainability. We made the modification but it was long and heavy. So we made it smaller and lighter. We had a discussion and some arguments about the modifications so we decided on the PVC extension.

We had to make sure our modification would not get in the way of the flow of the water around the Perch[5]. We also had to make sure the modification would not get in the way of the motors causing the Perch to veer off in the wrong direction[2].

Figure 1

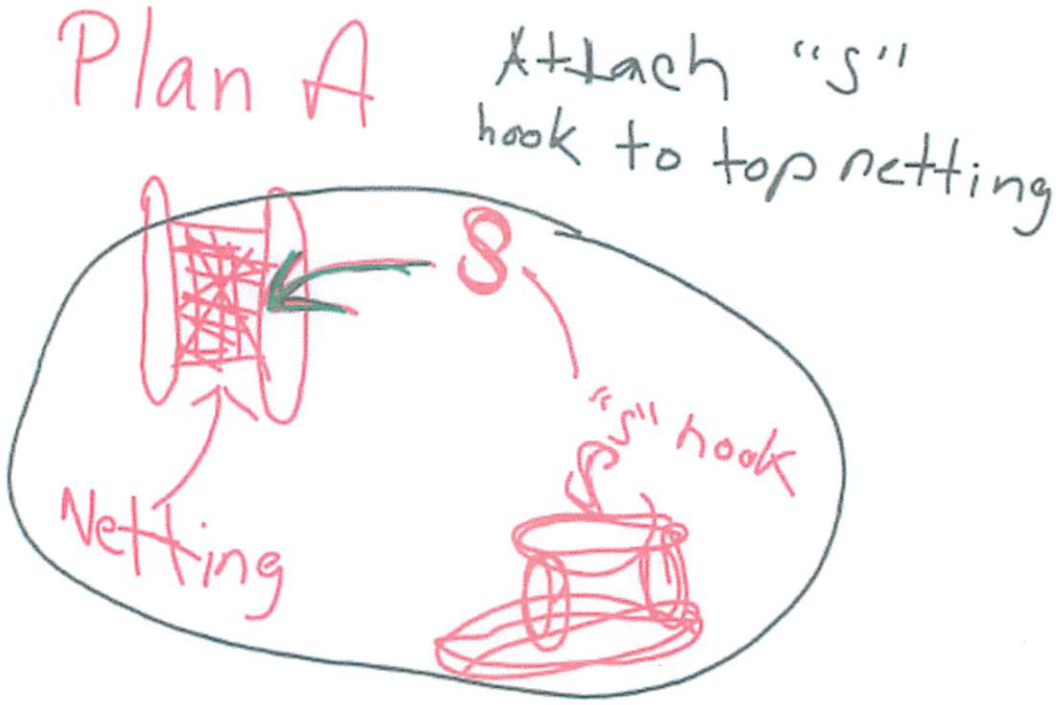


Figure 2

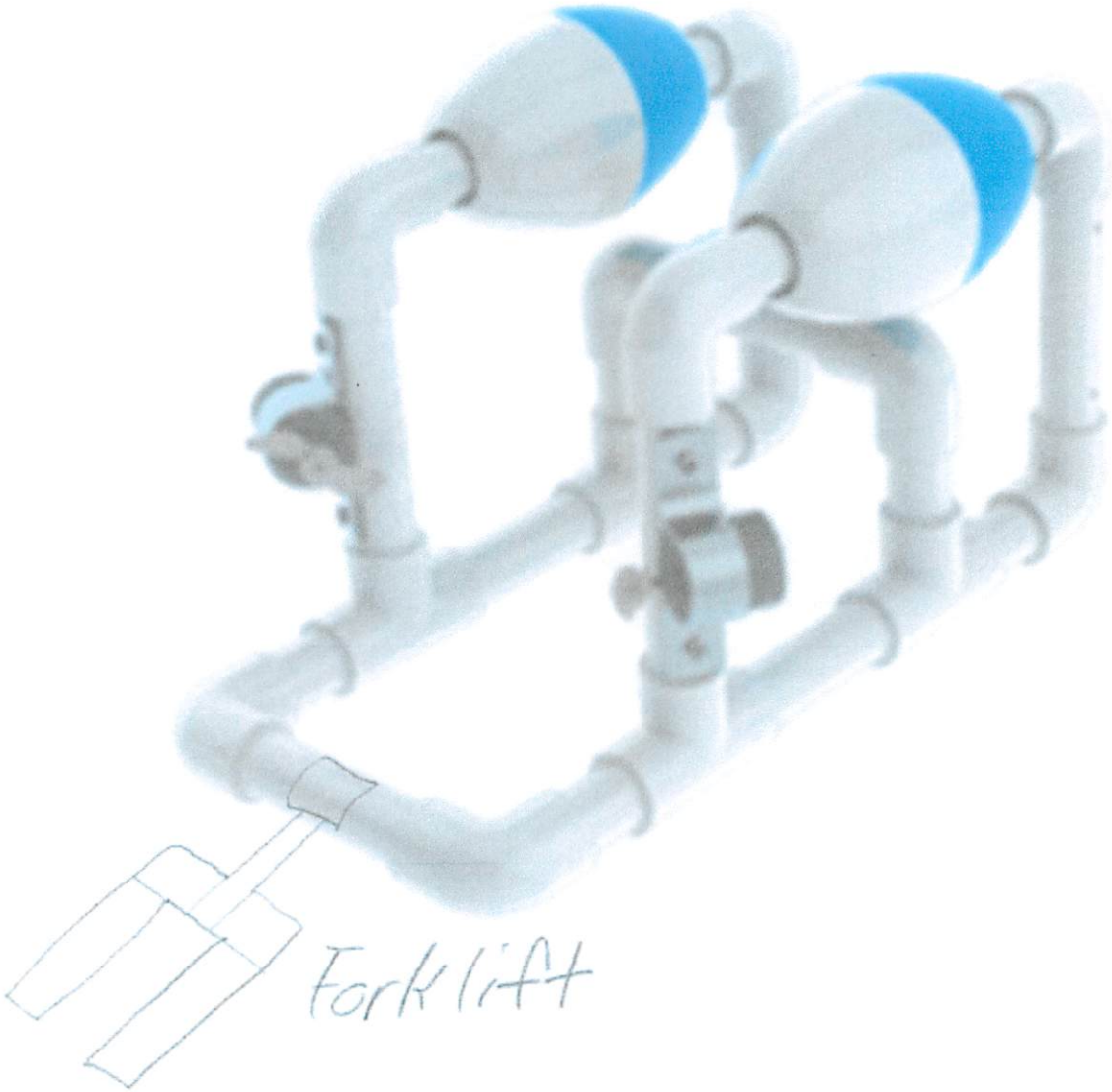


Figure 3

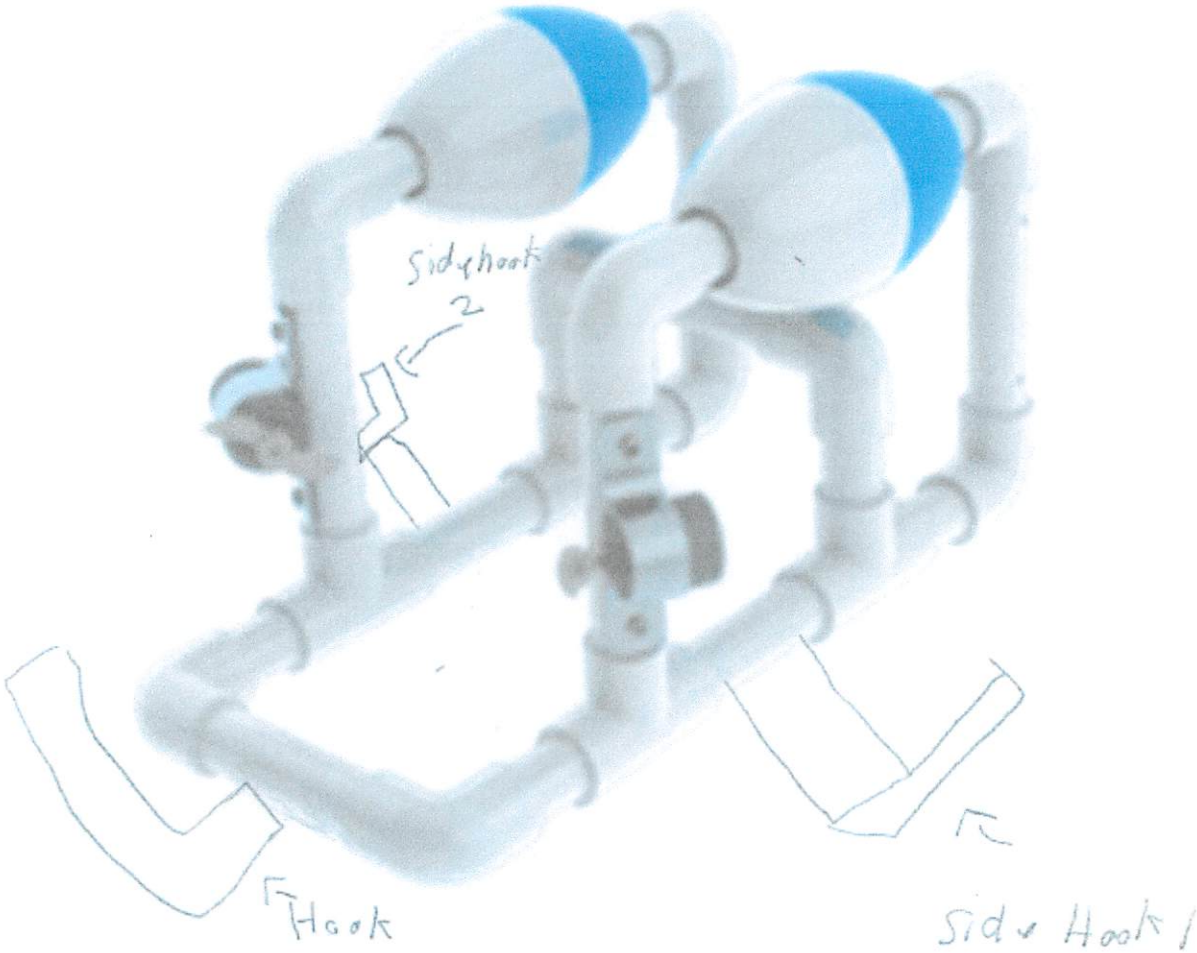


Figure 4

Figure 4.1

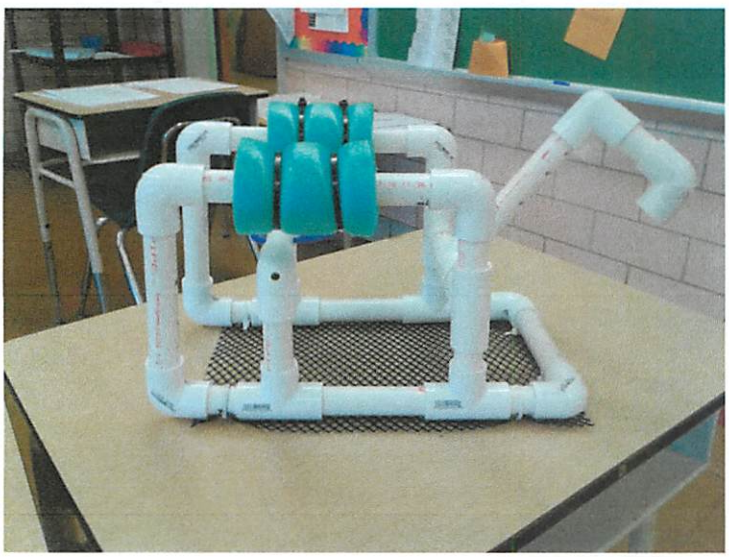
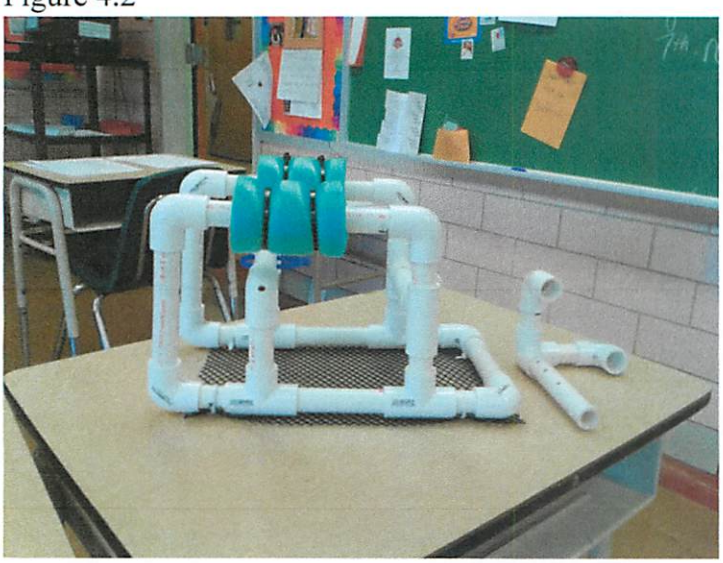


Figure 4.2



Our final design can achieve all of the tasks of the pipeline repair. It is optimized to stay out of the way of the motors when the SeaPerch is in motion. The modification can be removed for the agility challenge.

Experimentation

When designing our perch we experimented on the different parts that were necessary for it to work. Buoyancy[1] is an important factor for the challenges we're doing. It was also one of our problems. Another problem we had was not having a pool, which made it harder to experiment. One of our biggest problems was attaching a claw to the perch for the challenge. Weight was a concern when it came to this, as well as balance. This could determine the velocity and agility of our perch. After realizing that the claw would get in our way, we decided to take it out for the obstacle course. This benefitted us because it took weight away from the perch.

We have purchased a 45 gallon sterilite container to test the Perch in the classroom where we build the Perch. We have also learned about offsetting the weight of the modification with weights in the back of our Perch. Our engineering mentor taught us about displacement[5]. We determined that we used 97" of pipe and our modification weighs between five and six ounces[7]. This will be offset by washers attached to the back of the netting with wire ties.

Naval Scenario

- Could get to hard to reach places
    - Could reach places too small for a human
    - Could reach places too deep for a human
    - Could handle heavy pressures from the water
- If pipeline was underwater, SeaPerch could stay underwater for long periods of time unlike a human that would run out of oxygen
- The SeaPerch could have removable attachments for multiple jobs in the pipeline
- The SeaPerch can push a trigger to diffuse a dangerous situation that would put the naval engineers in jeopardy.

Teamwork

Team Members

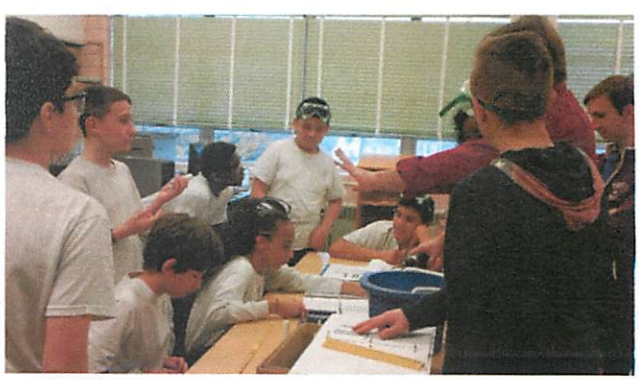
Jordan Borrero	Grade 8
Kevin Gomez	Grade 7
Andy Ha	Grade 8
Bryant Howe	Grade 7
Cameron James	Grade 8
Miguel Martins	Grade 8
William O'Shea	Grade 8
Anayah Rivas	Grade 8
Kiana Sampson	Grade 8
Tejan Sesay	Grade 8
Sean Sulaiman	Grade 7
Tomas Vallejo	Grade 8

Moderators

Andrew Bevilacqua

Scott Jackson

Charles Pavonarius



Sea Perch Agreement

At our first meeting, we signed off on the following agreement. It is included here as a kind of "constitution" about teamwork.

As part of the 2017 SeaPerch club I agree to the following statements:

I will practice science lab safety rules.

I will treat the equipment, tools, and kit as if it is my own.

I will arrive prepared to learn and perform at every session.

I realize that this is a school activity and should be treated as such.

I recognize time is valuable and I will make the most of my time in SeaPerch.

I will remember that the teachers are volunteering to be here with us.

I will treat my teammates with respect.

I will work hard because my teammates expect me to work hard.

I recognize that this is a challenge.

I was chosen because my teachers believe that I can rise to this challenge.

I know that everyone makes mistakes and that I might even make some.

I agree to encourage my teammates.

I will remember last season's challenges and adapt to new challenges.

I realize I will not always get to do the job that I want to do.

I believe that we can win but the treasure is being able to take part.

I realize that none of this is life and death.

I will learn and have fun.

By signing below we agree to these statements.

Distribution of Tasks

With 11 of 12 members returning to our team, we knew where our strengths and weaknesses lie.

We always meet for a few minutes to preview the day and set our goals.

With a team of twelve, we usually sort ourselves into two teams of six during the build.

While one team is measuring PVC, the other is cutting pipe. The measuring team might go over to the vices and start drilling.

We make sure everyone gets a chance to try the different tools, even if we won't be on that particularly team.

We worked in pairs on the notebook each taking a segment to brainstorm, formulate our thoughts, and then type it in the computer lab, which is across from the SeaPerch classroom.

Since we are losing nine eighth graders, we were careful to have our three seventh graders pay close attention to lead the team in 2018.

Discussion of Challenges

Our largest challenge is the control box. The soldering is an intricate task that takes a steady hand. It took us over two hours to do the control box. This year we purchased a new soldering iron that has made the job easier. We've also had a year of practice.

Another challenge is time. It seems that time goes so fast when we are at SeaPerch. You look up and an hour of our hour and a half session is gone. It all comes together in the end but it seems like we're always running out of time. Snow days don't help either.

We learned to measure twice and cut once but if the PVC is just a quarter inch off, it needs to be fixed. We have had to remeasure and recut pipe.

The pipeline repair has been a unique challenge. It has forced us to come up with a creative method to do all of the repairs while thinking about the added weight of our modification. We had to think about all of the things that needed to be done to fix the line.

The light will present a special challenge. As of February 15, we haven't begun to work on the light since we are still soldering the control box but we are confident it will all come together.

As long as we remember our school's motto that "We're better together." We will do well at competition on March 17.

List of Materials

In addition to our kit, we have used:

Approximately two additional feet of PVC pipe

One (1) PVC ½" "T"

One (1) PVC ½" corner

Two (2) PVC ½" elbow

Pending testing, we may need to add washers for weight which would include one (1) cable tie and washers. The cost is minimal.

Bill of Materials

Approximately two additional feet of PVC pipe ($7.08/10 ft)	$.78
One (1) PVC ½" "T" $2.62 for a pack of ten	$.26
One (1) PVC ½" 90' elbow	$1.14
Two (2) PVC ½" side outlet/elbow	$2.28
An unknown number of washers, nuts, and bolts (kit of 460)	$5.99
An unknown number of wire ties pending testing, pk of 100	$2.50
Superglue (3 pk. for $1.49)	$.50

Total expenditures $13.45

(Receipts to follow)

LOWE'S

LOWE'S HOME CENTERS, LLC
9701 EAST ROOSEVELT BLVD.
PHILADELPHIA, PA 19114 (215) 776-9006

– SALE –

SALES#: S1848TG1 1336857 TRANS#: 6177714 01-11-17

23891 3/4-IN SCH40 45 DEG ELBOW	0.97
24087 1/2-IN SCH40 CROSS 420005	1.32
315498 1/2-IN SCH40 SIDE OUT ELB	1.96
2 @ 0.98	
SUBTOTAL:	4.25
TAX:	0.34
INVOICE 06727 TOTAL:	4.59
CASH :	5.00
CHANGE:	0.41

STORE: 1848 TERMINAL: 06 01/11/17 10:35:26

OF ITEMS PURCHASED: 4

EXCLUDES FEES, SERVICES AND SPECIAL ORDER ITEMS

THANK YOU FOR SHOPPING LOWE'S.
SEE REVERSE SIDE FOR RETURN POLICY.
STORE MANAGER: PATRICK KIRBY

WE HAVE THE LOWEST PRICES, GUARANTEED!
IF YOU FIND A LOWER PRICE, WE WILL BEAT IT BY 10%.
SEE STORE FOR DETAILS.

****
* YOUR OPINIONS COUNT! *
* REGISTER FOR A CHANCE TO BE *
* ONE OF FIVE $300 WINNERS DRAWN MONTHLY! *
* ¡REGISTRESE EN EL SORTEO MENSUAL *
* PARA SER UNO DE LOS CINCO GANADORES DE $300! *
* *
* REGISTER BY COMPLETING A GUEST SATISFACTION SURVEY *
* WITHIN ONE WEEK AT: www.lowes.com/survey *
* Y O U R I D # 06727 1848 011 *
* *
* NO PURCHASE NECESSARY TO ENTER OR WIN. *
* VOID WHERE PROHIBITED. MUST BE 18 OR OLDER TO ENTER. *
* OFFICIAL RULES & WINNERS AT: www.lowes.com/survey *
****

STORE: 1848 TERMINAL: 06 01/11/17 10:35:26

THE HOME DEPOT

More saving.
More doing.℠

4640 ROOSEVELT BLVD. PHILA.,PA 19124
STORE MGR. WAYNE WRIGHT (215)-537-6100

4112 00057 27433 01/06/17 09:50 AM
CASHIER SELF CHECK OUT

611942090693 PVCSIDEOUTEL <A>	
1/2" PVC SIDE OUTLET EL SXSXFPT	
2@1.14	2.28
611942135059 10 PK TEE <A>	2.62
1/2" PVC TEE SXSXS 10 PACK	
SUBTOTAL	4.90
SALES TAX	0.40
TOTAL	$5.30
CASH	5.00
CASH	5.00
CHANGE DUE	4.70

4112 57 27433 01/06/2017 3059

THANK YOU FOR SHOPPING AT
S & H HARDWARE & SUPPLY CO.
(215) 745-9375

THANK YOU FOR SHOPPING S & H HARDWARE!
YOUR DECORATIVE HARDWARE & BATH SOURCE!
01/05/17 4:54PM EJ 563 SALE

43136	1	EA	.89 EA	
TEE 1/2" SXSXS SCH40				.89
43122	1	EA	.49 EA	
ELBOW 90 1/2" SXS SCH40				.49
GH	1	EA	1.49 EA	
HD S HOOK				1.49

SUB-TOTAL:$ 2.87 TAX: $ .23
TOTAL: $ 3.10
CASH TEND: 5.00 CHANGE: 1.90

==>> JRNL#B19272/1 <<==
CUST NO:*1
Customer Copy

ALL SALES FINAL
STORE CREDITS ONLY

- - - - - - - C O U P O N - - - - - - -

ELECTRICAL ITEMS NOT RETURNABLE

- - - - - - - C O U P O N - - - - - - -

HARBOR FREIGHT TOOLS
Quality Tools at Ridiculously Low Prices

JOHNSON CITY TN #00192
3302 W. MARKET ST. STE 5
JOHNSON CITY, TN 37604
Telephone: (423) 926-0616

SALE

Customer Name:	SCOTT W Jackson
Customer Number:	888021492353
34866 3 PC SCRAPER & KNIFE SET	0.89
62784 13PC PRECISION KNIFE SET	2.99
65167 3PC PEN STYLE PREC SCREWD	5.99
69405 TIES-11IN BLACK 100PK	2.49
63239 3/4 X 60 IND. ELECTRICAL	
2 x $0.79	$1.58
42367 SUPER GLUE 2 GRAM 3PK	1.49
67514 2 TIER EASY-STORE STEP LA	29.99
COUPON DISCOUNT	-10.00
New Price	19.99
Coupon Number 45261028	
Subtotal	$35.42
Sales Tax 9.5000%	$3.37
Total	**$38.79**
Additional Savings $10.00	
Gift Card	$38.79
No. XXXXXXXXXXXXXXX9829	
Auth. No. 001121	
Balance: $11.21	

Store: 00192 Reg: 01 Tran: 176552
Date: 12/30/2016 12:43:37 PM Assoc: XXXXXX
Ticket: 01176552

Item(s) Sold: 8
Item(s) Returned: 0

STEVEN served you today.
Thank you for shopping at
JOHNSON CITY TN #00192

Proof of Purchase Required for Returns/ Exchanges Within 90 Days of Purchase.

GENOVA

1/2" x 10 ft. CPVC Pipe, Pipe Schedule SDR 11, Non-Threaded

Item# **46KK62** Mfr. Model# **500055** Catalog Page# **N/A** UNSPSC# **40142115**

List Price
$7.08 / each

Get This Price
$5.66

This item requires special shipping, additional charges may apply.

Auto-Reorder Every 1 Month

Deliver one time only

1 ADD TO CART

+ Add to List

Confirm ZIP Code to determine availability.

77001 SAVE

☆ ☆ ☆ ☆ ☆ **Be the first to write a review**

Shipping Weight **0.74 lbs.**

How can we improve our **Product Images**?

Compare

Country of Origin **USA** | *Country of Origin is subject to change.*

Note: Product availability is real-time updated and adjusted continuously. The product will be reserved for you when you complete your order. More

TECHNICAL SPECS

Item	**Pipe**	Pipe Size (Nominal)	**1/2"**
Pipe Type	**Pipe**	Overall Pipe Length	**10 ft.**

460 Piece Nut and Washer Assortment

Storehouse® - Item#67624

Hex nuts, flat and lock washers and hex head bolts in an organized container

comp at $10.97

Only: $5.99

Description

Specifications

Name	460 Piece Nut and Washer Assortment
SKU	67624