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Seawater Distiller (Solar Collector for Heating Seawater)

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(Solar Collector for Heating Seawater)

By

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Project Partner

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Abstract

Many people in the world globally have limited or no access to clean drinking water. Unclean drinking water is a major cause of deadly diseases such as typhoid, cholera, and other water-borne diseases. The motivation of this report aims to document a senior project to satisfy for the award of MET by CWU. The aim was to design and manufacture a solar thermal collector capable of heating water using solar energy. The solar collector was developed by designing and fabricating a parabolic reflective surface. The reflective surface was manufactured from a reflective stainless-steel sheet. The advantages of using a parabolic reflective surface include improvement in operational efficiency and easy to estimate the required water flow. The desired solar input was also estimated. Similarly, the necessary water pipe diameter and length were designed. A stand was manufactured by assembling various parts. The design of the collector stand and frame depended on the size and portability of the solar thermal collector. Other factors included the area of use and ease of use. The stand material strength, static and dynamic structural analysis were put into consideration. The result in the design and manufacture of a stand with ease use, operate and transport. The devise was manufactured by assembling the solar thermal collector, stainless steel water pipes, steel frame, and wood stands as per the design and working diagram. This resulted in the efficiency and heating capacity of the collector to be 95^{o}C. Also, the devise was able to absorb and utilize at least 70% of the incoming solar radiation on a day where irradiance is equal to 800 W/m2.

Table of Contents

INTRODUCTION

One of the basic human needs is access to clean drinking water. However, many people in the world globally have limited or no access to clean drinking water. Unclean drinking water is a major cause of deadly diseases such as typhoid, cholera, and other water-borne diseases. The purpose of a Seawater Distiller was to provide access to clean drinking water when clean water supplies are not available by heat water using solar energy as the only input.

Description:

Using Solar powered water heater to supply water vapor to the condenser of a distiller for seawater

Motivation:

This project was motivated by a need to clean and treat water before drinking. One method of treating drinking water is boiling. Boiling requires the use of fuel or electricity. There is no abundant supply of fuel in rural parts of Saudi Arabia. Besides, use of electricity is an expensive method. Furthermore, not everyone is connected to the main grid. One of the cheapest and reliable source of energy for treating water is solar energy.

As stated, solar energy is cheap and reliable as long as there is the sun. There are many solar-powered water distillation devices in the market. However, these devices are expensive, bulky, and less efficient. Therefore, there is need of developing a solar device that is cheap, efficient and simple to manufacture and use. The device can be developed through research, experimental and improving on the shortcomings of the existing devices.

Function Statements:

The solar powered for Seawater Distiller was collect solar energy to heat water to vaporization temperature so that it can be condensed into distilled water.

Requirements:

The solar powered for Seawater Distiller must hold to these requirements:

- Prototype collector to be no more than 24 x 50 inches for going through doorways etc.

- Be able to absorb and utilize at least 70% of the incoming solar radiation on a day where irradiance is equal to 800 W/m2.
- The result in the efficiency and heating capacity of the collector to be 95^{o}C.
- Cost no more than $500 to manufacture.
- The device must be transportable simply for a long distance and it is required no more than 25 lbs. of force to hold up when the device is transport.
- Weight no more than 100 lbs.
- Take no more than 30 hours to manufacture.

The scope of this effort:

The scope of this project was the solar collector tube efficiency. The water container, piping, and stand are already in the lab storage cupboard. Kumail Alshagag was doing condensation unit.

The Success of the Project:

The primary function of this stand is collect solar energy to heat water to vaporization temperature so that it can be condensed into distilled water. a combined weight of 100 lbs.

DESIGN & ANALYSIS

Approach:

There is a need to develop a device that can heat seawater in a distiller using solar energy. This process was required the design and manufacture of an acrylic mirror sheet reflector and solar collector tube efficiency. These devices are made from parabolic sheets and have the ability to solar energy. They convert the solar energy into heat energy. The collector contains a stainless-steel pipe running throughout its entire length. As the water slowly moves through the water tube, it is heated. To determine how to design the solar collector to generate the desired output, a few factors have to be determined or assumed. **Q=E1+E2** (E1= energy to reach boiling point, E2 = energy required for phase transaction) was using to find total energy required for distillation.

Design Description:

The design comprises of a reflective stainless sheet curved to form a parabolic reflective (Figure 2-1). The parabolic shape helps in concentrating the sunlight rays to a focal line where heating is done. Unlike a dome shape that has a constant focal line, a parabolic reflector is advantageous as the focal line keeps on changing depending on the position of the sun.

Benchmark:

The benchmark for the seawater distiller is Solar Stills. Solar still is a cheap way of distilling water using low tech. The process is powered by solar energy. There are two types of solar stills. These are box and pit solar stills. In this method, clean water kept outside the collector is heated by solar energy until it evaporated and recollected on a clean plastic. The water condenses and is collected in pebbles located in the low points. However, the seawater distiller would be easy to move the whole part by using wheels to be easy to carry anywhere beside Solar Stills that should be in one place forever because there are box and pit solar stills.

Performance Predictions:

Solar Water Purifier is predicted to have a solar efficiency of 70 %. This means, itis able to absorb and utilize 70% of the incoming solar radiation on a day. The solar collector was expected to cost $ 500 to manufacture. The project includes the acrylic mirror sheet reflector, solar collector tube efficiency (stainless steel pipe), frame, parabolic sheets and have the ability to solar energy.

Description of Analyses:

As showing in Appendix A. First, figure A-1 shows a simple drawing for the project (the Seawater Distiller) that include the stainless-steel pipe and reflector surface. Second, figure A-2 shows the flowing steps for the project and how the project works which is staring from seawater going through the pip that can heat seawater in a distiller using solar energy by pump. Third, figure A-3 shows how much amount of power could have from reflector surface which is 203 W by using the power formal. This was starting by determined the size of the reflector surface which is 50 x 24 inches to give how much amount of power could have. Fourth, figure A-4 shows the length of the stainless tube 54 inches with outside diameter 1” and inside diameter 0 902” and wall thinness 0.049”. Fifth, figure A-5 shows how much amount of clear water could have by using the fluid formal which is 36 ml/min. Sixth, Figure A-6 to A-8 shows the parabola calculation and the calculation, it could find curve for the parabola. What is parabola? Parabola mathematical is analysis of the cut surface shows a distinct property every point on a parabolic curve is equal a point and a line between each other. $X^2 = 4ay$ the formal was using to determent the focus point. The focus point was 6. Seventh, Figure A-9 shows the calculations from the equations $Re = \rho vD/\mu$ and $mdot=\rho vA$ for the Reynolds number of the water in the collector pipe. The Reynolds number of 570 signifies laminar flow. In this way, some type of static blender was using to mix the water. Eighth, Figure A-10 shows the calculations of the velocity of the water in the solar collector. As shown, the water velocity 1.25 cm/s.

Scope of Testing and Evaluation:

The scope of testing and evaluation on the solar collector must has at least 70% of the potential solar flux

Analyses:

Design Issues

- The first design was to find the pip size.
- The second design issue was to find the size of the for the reflector sheet

Calculated Parameters:

The appendix of the analyses shows the calculations required to guarantee an effective preparing stand. The calculations resolved to explain the above design issues.

As showing in Appendix A. First, figure A-1 shows a simple drawing for the project (The Solar Collector) that include the stainless-steel pipe and reflector surface. Second, figure A-2 shows the flowing steps for the project and how the project works which is staring from seawater going through the pip that can heat seawater in a distiller using solar energy by pump. Third, figure A-3 shows how much amount of power could have from reflector surface which is 203 W by using the power formal. This was starting by determined the size of the reflector surface which is 50 x 24 inches to give how much amount of power could have. Fourth, figure A-4 shows the length of the stainless tube 54 inches with outside diameter 1" and inside diameter 0902" and wall thinness 0.049". Fifth, figure A-5 shows how much amount of clear water could have by using the fluid formal which is 36 ml/min. Sixth, Figure A-6 to A-8 shows the parabola calculation and the calculation, it could find curve for the parabola. What is parabola? Parabola mathematical is analysis of the cut surface shows a distinct property every point on a parabolic curve is equal a point and a line between each other. $X^2 = 4ay$ the formal was using to determent the focus point. The focus point was 6. Seventh, Figure A-9 shows the calculations from the equations $Re = \rho vD/\mu$ and $mdot=\rho vA$ for the Reynolds number of the water in the collector pipe. The Reynolds number of 570 signifies laminar flow. In this way, some type of static blender was using to mix the water. Eighth, Figure A-10 shows the calculations of the velocity of the water in the solar collector. As shown, the water velocity 1.25 cm/s.

Device: Parts, Shapes, and Conformation

The seawater distiller (The solar collector) was manufactured following parts:

WELDED STAINLESS TUBE 304/304L
For reflector surface, galvanized sheet steel, aluminum, or sstl, 22 gauges (.030 in)
Domestic aluminum square pipe (1.5 ”)
Reflective acrylic sheet (2mm)
Nuts and bolts and washers (6 mm dia d 2.5”)
1 inch screws (3 mm dia)
Wood board 1”
Wheel (10” dia)
Wire Round Lock Pin
1" Tube OD x 3/4" MNPT SS Fitting Swagelok

Device Assembly

This device consists of the parts listed in Parts, Shapes, and Conformation above. All parts were secured to each other with the latches recorded inside the appendix.

Tolerances, Kinematics, Ergonomics:

Tolerances:

Tolerances for the frame can be genuinely low, as a large portion of the associations was welded, and the rest was secured with clasp. For a many of the bigger bars, tolerances were fall within + or - .1 in. For the drilled holes were required .05”. The locking bar was required somewhat more accuracy at + or - .01" and it made after the casing is frame and authority connected.

Kinematics:

The project was designed to be mobile, however the majority of the parts was remaining stationary with respect to the frame when transport. The authority should turn, and was required sufficient freedom to do as such. A locking bar with bored openings and a stick was securing this when wanted rotational edges are accomplished.

Ergonomics:

As examined over, the power examination of the get together was giving an ideal situation to the hub with the goal that it was less demanding to tip for transport and require less power to hold at the coveted transport point.

Technical Risk Analysis, Failure Mode Analyses, Safety Factors, Operation Limits

There are many sorts of possible risks. For example, there is a budgetary danger of going over spending plan. The budget for this project was $500. There was also additionally of a scheduling risk. The Seawater distillers was required to take close to 30 hours to manufacture.

METHODS & CONSTRUCTION

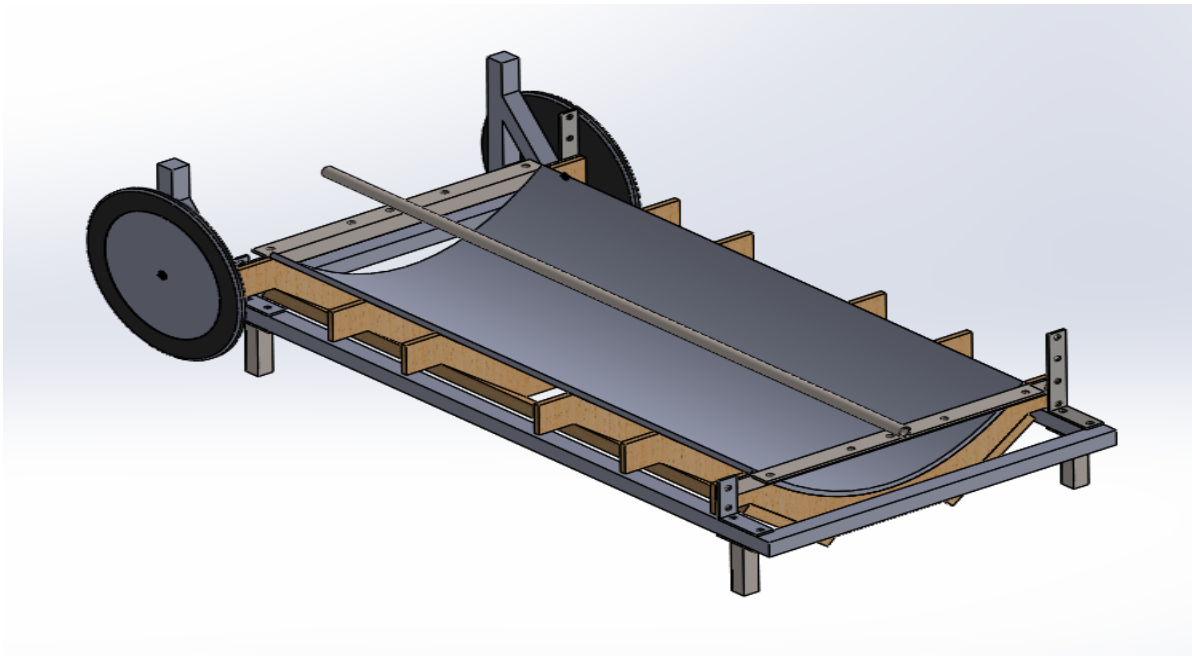
Methods:

This project was designed and analyzed using resources and personnel at Central Washington University Mechanical Engineering Technology department. The project parts were also manufactured and fabricated at the Mechanical Engineering Technology department. Appendix B shows all the parts was manufactured and fabricated.

Construction:

The Seawater Distiller (The solar collector) was constructed out of a reflective stainless sheet curved to form a parabolic reflective, a frame of steel, stainless-steel pipe, the wood stand. The stand was assembled from various parts. These parts were fabricated or purchased depending on the material availability. Assembled parts include locking bar pin, wheels, collector, mountings, fasteners, and hinges. Design considerations were taken into account to have a minimum number of assembled parts. The stand base frames are to be fabricated using L-shaped bars. On the other hand, the connector plates, locking bar and support bar are fabricated using flat-shaped bars and the frame fabricated using square tubing.

The final construction was resembled figure B-19:

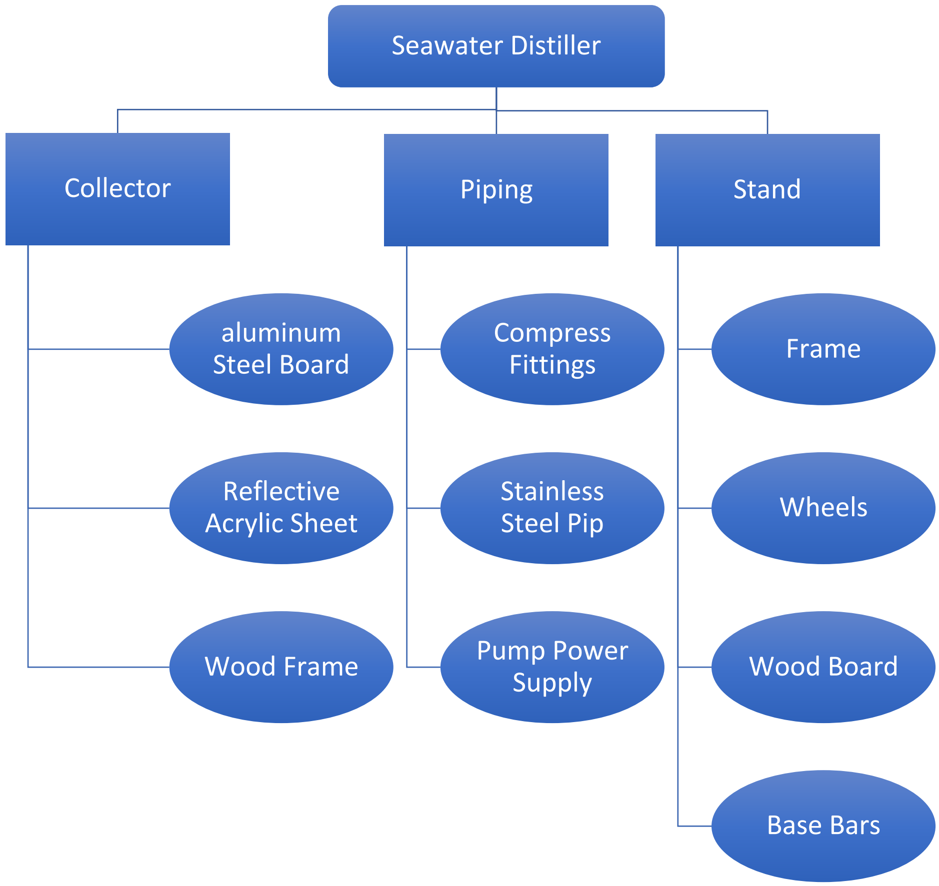


Description:

The design comprises of a reflective stainless sheet curved to form a parabolic reflective (Figure 2-1). The parabolic shape helps in concentrating the sunlight rays to a focal line where heating is done. Unlike a dome shape that has a constant focal line, a parabolic reflector is advantageous as the focal line keeps on changing depending on the position of the sun.

The stand plays an important function in the functionality of the stand. Its main function is to provide support to the solar collector. The axles, with the wheels attached to it, was fastened to the stand’s base frame. Other parts of the base were shaped and welded. The parabolic solar reflector’s frame was fabricated from L-shaped bars, holes drilled and fastened on to the wood board base. Similarly, the square tubing was drilled and fastened to construct the upright frame. Holes were also drilled for attachment of the handles.

Drawing Tree:



Parts list and labels:

Refer Appendix (C) list and costs/budget for a detailed parts show; it contains all the data important to finish the manufacture.

Part	Quantity	Source	Estimated Cost	Actual Cost	Total Cost
WELDED STAINLESS TUBE 304/304L	1 pcs (60") Wall 0.049	www.onlinemetals.com	52 $	35$	35 $
For reflector surface, galvanized sheet steel, aluminum, or sstl, 22 gauges (.030 in)	1 pcs (50X28.5)	www.onlinemetals.com	70 $	35$	35$
Domestic aluminum square pipe (1.5 ")	2 pcs (90")	http://www.onlinemetals.com	35 $	37$	37
Reflective acrylic sheet (2mm)	1pcs (50 in x 28.5 in)	amazon.com	10 $	19.47$	19.47$
Nuts and bolts and washers	32 pcs	www.amazon.com	0.50 $/ pcs	0.50 $/ pcs	16 $

(6 mm dia d 2.5”)					
1 inch screws (3 mm dia)	10 pcs	www.amazon.com	0.39 $/ pcs	0.39 $/ pcs	3.90$
Wood board 1”	2 pcs (50in x 9.5)		0 $	0 $	0 $
Wheel (10” dia)	2 pcs (10”)	amazon.com	14.99 $	14.99 $	14.99
Wire Round Lock Pin	1x 3/8” x 3”	Home depot	10.88$	10.88 $	10.88$
1" Tube OD x 3/4" MNPT SS Fitting Swagelok	2 pcs	ebay.com	27.20 $ per pcs	18.75$	37.5$
Total			315.18$		294.74$

Figure C-1

Manufacturing issues:

A few minor issues were faced in manufacturing. first issue was the wheels that were purchased were not the same as the ones designed because the Alloy Round Bar for wheels bar were shorter than the width of the frame and the wheels diameter were smaller than the ones designed. This required to purchase a new Alloy Round Bar than can be long enough to fit the width of the frame. After purchased Alloy Round Bar was needed making 4 small holes for holding the wheels. The wheels diameter was not needed to replace but this required adjustment of the hole locations in the frame. Adjustment of the hole locations in the frame required a redesign square tubing the bottom of the frame that can fit the wheels diameter. Also, MET 345 - Lean Manufacturing was not taken before and the project needed using CNC machine for cutting the woods (Figure B-4). Last issue was using the saw cutting for cutting square tubing by 45 degrees. This required a few extra hours of to know how to use saw cutting.

Manufacturing Discussion:

The fabrication and manufacturing process strictly followed the schedule. The manufacturing and fabrication process encountered few problems such as delays in the purchase of material and non-workable designs. These issues lead to redesigning. Another issue experienced was receiving materials as single pieces. It led to some delays since it is simple to carry out all the constructions procedures with a uniform manufacturing workshop layout. However, the mistakes were rectified and the stand fabricated earlier than expected.

Discussion of Assembly:

The project was an assembly of many different parts that in appendix (B). Figure B-1 shows the most important part of this project which is reflective stainless sheet curved. Reflective stainless sheet curved could help to know how much power can have from reflective stainless sheet curved. Figure B-2 shows the pip was using for this project. The pip size was 54 in length with outside diameter of 1 inches and inside diameter 0.75 inches. Figure B-3 shows first part of wood board. The wood frame was making out of 50 ft. by 9.5ft. Also. Figure B-4 shows the sound part of wood that made from the CNC machine because the CNC machine could cut this part to fit the reflective stainless sheet curved. Figure B-5 shows the stand for the project. This part could use for two things, first it was using for moving the project, second this part was using for standing the project on the ground. Figure B-5, Figure B-6, and Figure B-7 was using to hold two parts together. Figure B-8 shows the L-bar that was stand for holding on the top and bottom of the reflective stainless sheet curved. Figure B-12 to 18 show all parts for the frame. The frame was made from cutting square. The length of frame was 68 inches and the width was 30 inches. In figure B-9 shows assembly resemble for the frame.

TESTING METHODS

Introduction:

The purpose of testing method for this project was to provide access to clean drinking water when clean water supplies are not available but nondrinkable water and solar energy is available. Testing on Outdoor Weather ability. The finished device must be:

- Prototype collector to be no more than 24 x 50 inches for going through doorways etc.
- Be able to absorb and utilize at least 70% of the incoming solar radiation on a day where irradiance is equal to 800 W/m2.
- The result in the efficiency and heating capacity of the collector to be 95^{o}C.
- Cost no more than $500 to manufacture.
- The device must be transportable simply for a long distance and it is required no more than 25 lbs. of force to hold up when the device is transport.
- Weight no more than 100 lbs.
- Take no more than 30 hours to manufacture.

Method/Approach:

First part of test was the device must be transportable simply from inside Hogue building to outside the building and it is required no more than 30 lbs. of force to hold up when the device is transport.

The project was using solar power to distill seawater into drinking water. A concentrating solar collector was used to focus the solar energy onto a collector tube to produce hot seawater at 95C. Several methods are expected to be used to test the performance of the solar collector. The first method was involving measurement of the incoming solar irradiance using weather condition data outside Hogue Technology building Secondly, the temperature difference between the input and outlet water was measured. An efficient solar collector should have a temperature difference of about 95 degrees Celsius. For better results, the performance testing methods should be done at an interval of 20 minutes for a period of 2 hours. Other data that can be collected during the testing process include the solar collector dimensions, Cp, and water density. These data were helping in calculating the heat transfer coefficient, Qdot.

Test Procedures:

The testing for the device was on two test parts:

Test 1: Transport and weight of the device.
Time: 10 minutes.
Place: Outdoor
The following steps for testing 1:

1. Making sure a concentrating solar collector is locked by locking pin that concentrating solar collector is not moving.
2. Transport the device easily by rolling on attached wheels from inside building to outside the building (similar to a hand truck).
3. Set down the device vertically slowly.
4. Remove locking from a concentrating solar collector and set up a concentrating solar collector 30°
5. The entire device should place in direct sunlight with collector tube aligned on the east to west polar axis (not magnetic poles).
6. Measure Prototype collector to make sure if it is no more than 24 x 50 inches by using Tape Measure.

Test Documentation and Discussion:

The following figure (E-1 in appendix E) shows the result of test Transport and weight of the device.

Task	Requirement	Actual	Success
1- Transport device	Simple	Simple	Yes
2- Weight	No more than 100 lbs.	90 lbs.	Yes
3- Force to hold up	25 lbs.	20 lbs.	Yes

Figure E-1

Safety:

Safety must be taken when removing the device not damage because the device weighs over 80 lbs. Also, Stepdown the device vertically carefully because the device heavy.

Test 2: The performance of the solar collector
Time: 30 minutes.
Place: Outdoor
The following steps for testing 2:

1. Measure solar irradiance by using weather.com, Licor Li-200SA sensor or another device.
2. Measure inlet and outlet seawater temperatures by using Thermometers.

Test Documentation and Discussion:

The following figure (E-2 in appendix E) shows the result of test the performance of the solar collector.

Trial	**Time** (Minutes)	**Solar irradiance** (W/m^2)	**Inlet temperatures** (^oC)	**Outlet temperatures** (^oC)	Q_{in} (W)	Q_{out} (W)
1	30	923	23	95	686	104.4
2	28	932	23.5	95	577	111
3	28	932	23.5	95	577	111
4	32	920	23	95	570	97

Figure E-2

Safety:

Safety must be taken when testing the performance of the solar collector not to touch the stainless-steel pipe because it is heating in high temperature and this might lead to burn the hands or fingers.

Deliverables:

Hot seawater was produced at 95C. Reservations are supposed to be made prior to the testing. These reservations include the lab technician facilitating transportation of the solar collector to the testing site. The collected data was compiled and recorded on the evaluation sheet.

BUDGET/SCHEDULE/PROJECT MANAGEMENT

Cost and Budget:

One of the requirements was a sensible materials cost of under $400 Appendix C contains a parts list in Figure C-1 with associate costs from possible suppliers. The budget includes parts, transportation, and labor the parts list includes an estimated and actual cost of each item was purchased, the place of purchase, and a description of each item. The actual cost of the project was $ 294.74 which is much chapter than was estimated $400.

Appendix C shows a full parts list for the project. the part was purchased at the begging of the quarter. These parts include: WELDED STAINLESS TUBE 304/304L, reflector surface, aluminum sheet steel, aluminum, Domestic aluminum square pipe (1.5"), Reflective acrylic sheet (2mm), Nuts and bolts and washers, Wood board 1", Wheel (10" dia), Wire Round Lock Pin, Wire Round Lock Pin, 1" Tube OD x 3/4" MNPT SS Fitting Swagelok, and Pump.

Part	Quantity	Source	Estimated Cost	Actual Cost	Total Cost
WELDED STAINLESS TUBE 304/304L	1 pcs (60") Wall 0.049	www.onlinemetals.com	52 $	35$	35 $
ALUMINUM BARE SHEET	1 pcs (50X28.5)	www.onlinemetals.com	70 $	35$	38$
Domestic aluminium square pipe (1.5 ")	2 pcs (90")	http://www.onlinemetals.com	35 $	37$	74$
Reflective acrylic sheet (2mm)	1pcs (50 in x 28.5 in)	amazon.com	10 $	19.47$	19.47$
Nuts and bolts and washers (6 mm dia d 2.5")	32 pcs	www.amazon.com	0.50 $/ pcs	0.50 $/ pcs	16 $
1 inch screws (3 mm dia)	10 pcs	www.amazon.com	0.39 $/ pcs	0.39 $/ pcs	3.90$
Wood board 1"	2 pcs (50in x 9.5)		0 $	0 $	0 $
Wheels (10" dia)	1 pcs (10")	amazon.com	14.99 $	14.99 $	14.99
Wire Round Lock Pin	2 pcs	Home depot	10.88$	10.88 $	21.74$
1" Tube OD x 3/4" MNPT SS Fitting Swagelok	2 pcs	ebay.com	10 $ per pcs	18.75$	37.5$
Total			257.77$		260.62$

Figure C-1

Schedule:

The schedule was portrayed in an Appendix D. The schedule is further divided into plans per quarter. Some of the crucial activities in the project are developing and writing the proposal, dimensional and material analysis, sub-assembling, assembling, developing the collector's frame, and testing of the device. The schedule depends on the intensity of the work, time, and availability of materials. Figure D 1 and 2 shows details of the sub-assembling and assembling schedule. There are a few points of reference, for example, joining of 3D models

DISCUSSION

Project Risk analysis:

The biggest risk factor that taken into consideration was time. The project was characterized by many redesigns and analysis, revising of the proposal, and material selection. This lead to wastage of valuable time. It also leads to cancellation of the analysis of some parts. The assembling and building phase also poses some risks. Many parts need to be machined and fabricated for the short remaining time. Lastly, lack of expert skills in production processes such as welding and folding are potential risk factors.

Successful:

The success of this project to this far is attributed to the vast engineering knowledge in project management and planning, material science, mechanical design using Autodesk AutoCAD and SolidWorks engineering software, Gantt charts, heat transfer, and production. However, the project has been challenging. This is because the project was an original work that is developed from the challenges that faced. Some of the challenges experienced include over-designing, material selection and analysis, and fabrication methods. That gave the ability to work on a tight schedule to ensure that the project was completed on time. With only a few weeks remaining, the project management process was continuing well as per the schedule.

CONCLUSION

The reason for this project was using skills in Mechanical Engineering Technology major. The main objective of this project was design and fabricate a seawater distiller attached to a parabolic solar collector seawater with improved efficiency and an easy to transport stand on which. The main aim of the project was distilling water using solar energy that is cheap. In addition, the project aims at using resources that have minimal cost. The purpose of a Seawater

Distiller (Solar Collector) is to provide access to clean drinking water when clean water supplies are not available but nondrinkable water and solar energy is available.

The first step of the project development was coming with a skeletal sketch of the project. A lot of research and benchmarking was done assert the viability of the project. In addition, experiments were carried out to ascertain various theoretical work behind the project. All these steps were done using suing the cheapest methods available.

Even though the assembled device did not meet all the economic and engineering requirements, the project analysis and prediction was successful. The project was also functionally successful. The device meets all the health and safety considerations.

Lastly, the project was successful due to the support of all the mentoring and financial assistance from various sub-departments in the Mechanical Engineering Technology department.

ACKNOWLEDGEMENTS

A huge thanks to Professor Roger Beardsley, Professor Charles Pringl, Dr. Craig Johnson, Professor Ted Bramble, Mathew Burvess, and Mechanical Engineering Technology department at Central Washington University. Professor Roger Beardsley went as a guide through the whole project. The resources at Central Washington University was really helping, the seawater distiller project would not be constructed without those resources.

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APPENDIX A – Analyses

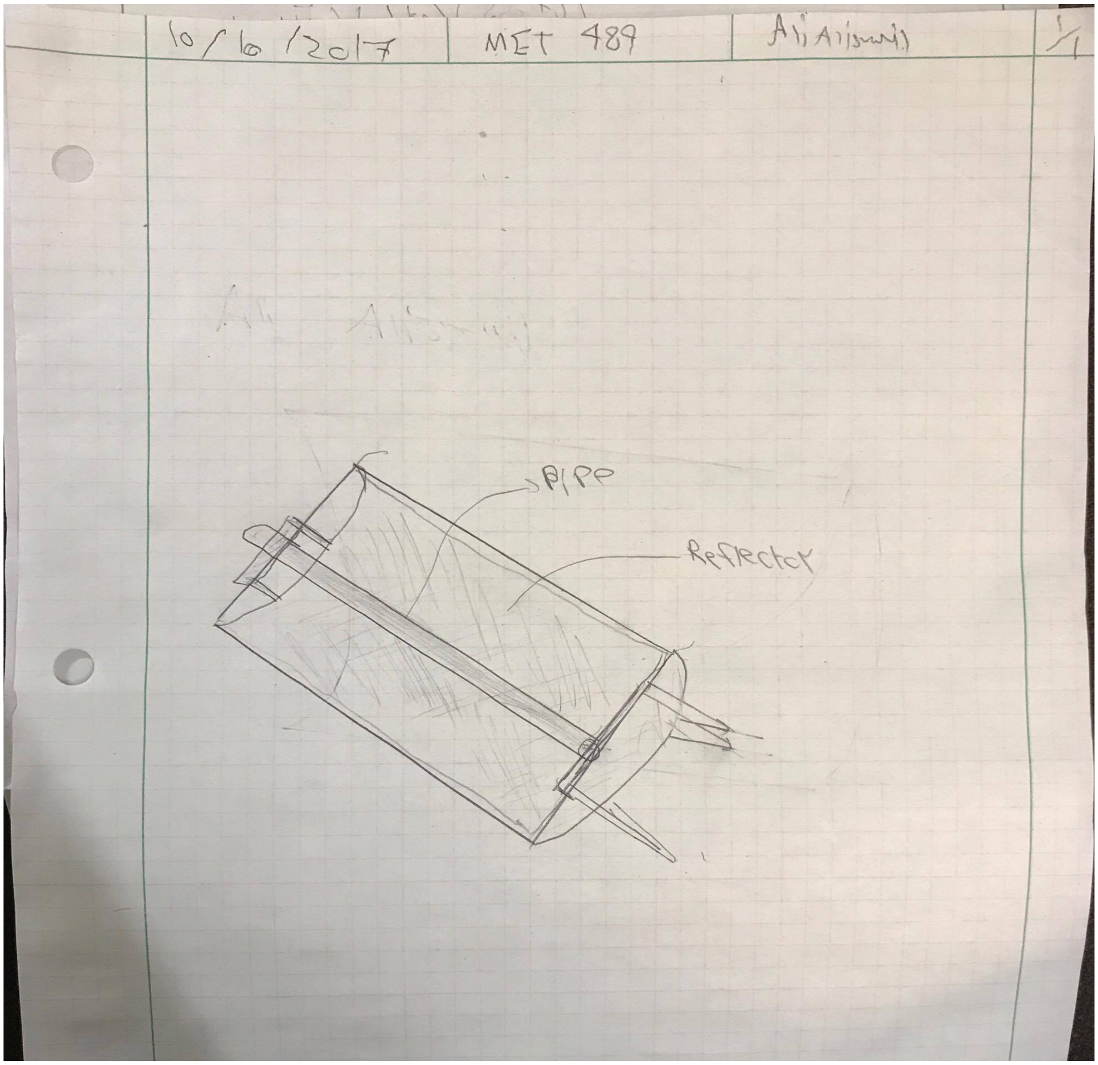


Figure A-1

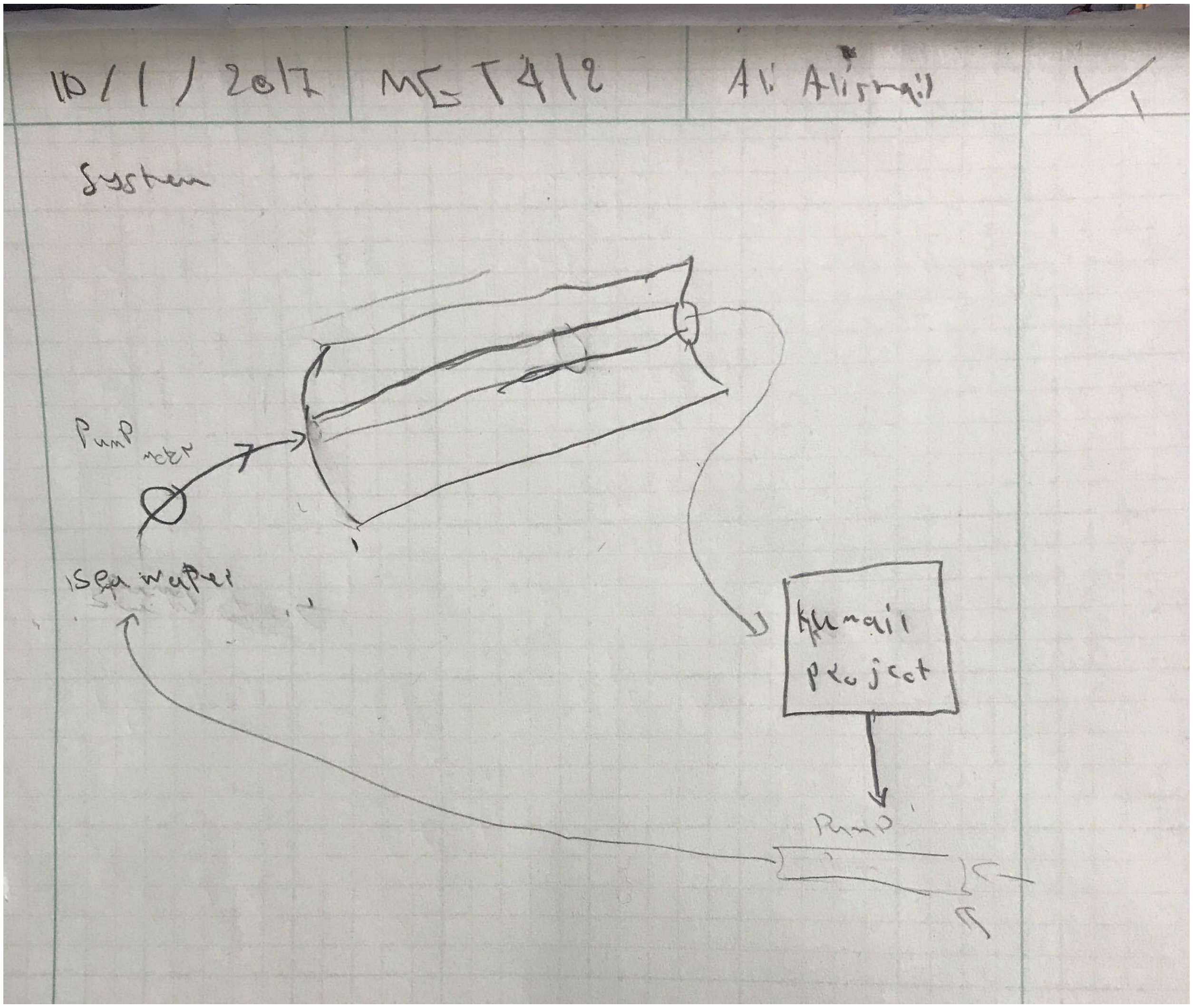
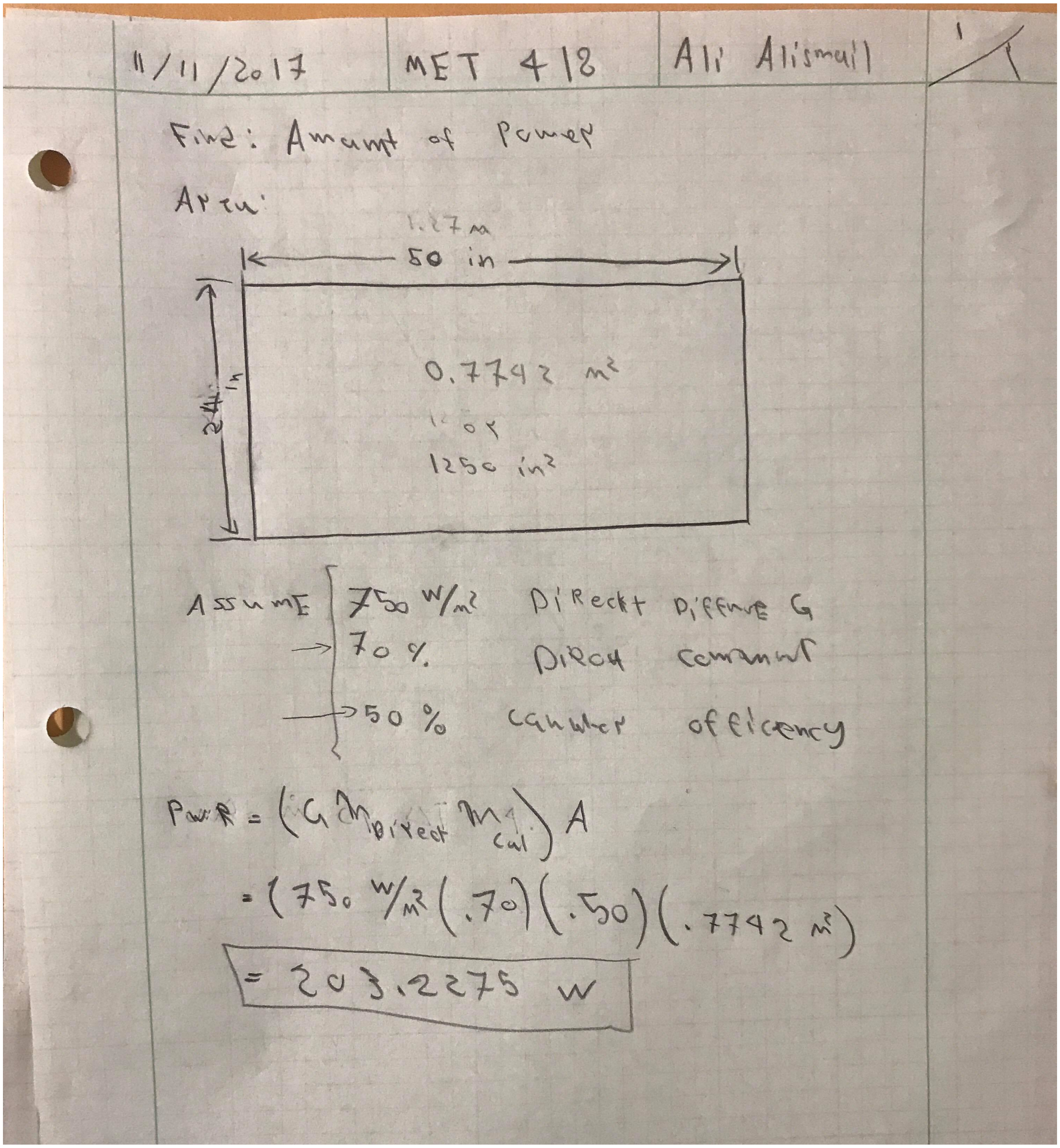
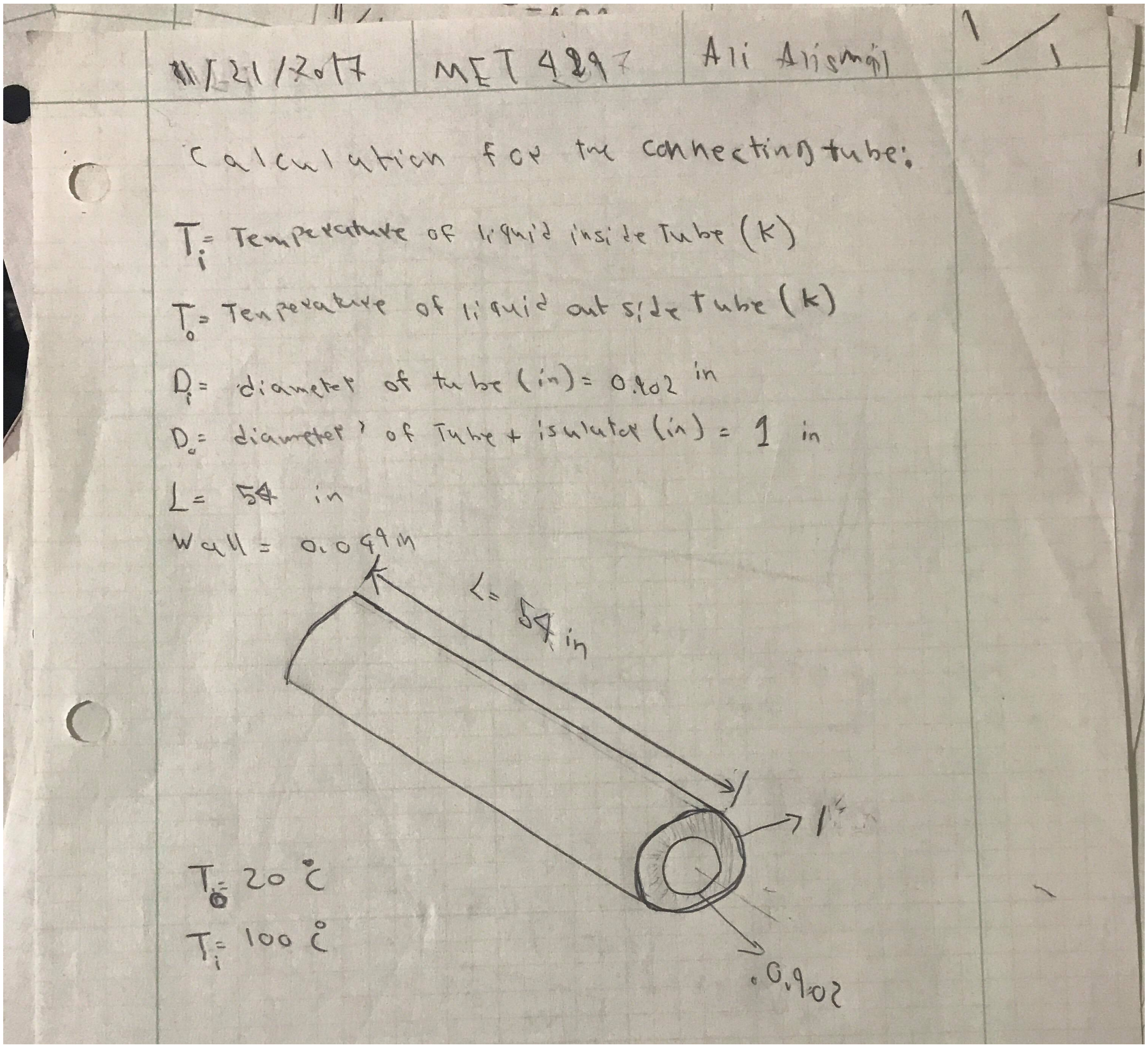

10/1/2017
MET 412
Ali Alismail
System
Pump
sea water
project
Pump

Figure A-2


11/11/2017
MET 418
Ali Alismail
Find: Amount of Power
Area:
1.27 m
50 in
24 in
0.7742 m²
or
1250 in²
Assume
750 W/m² Direct Diffuse G
70 % Direct component
50 % Converter efficiency
Power = (G η_direct η_cal) A
= (750 W/m²)(.70)(.50)(.7742 m²)
= 203.2275 W
Figure A-3


11/21/2017
MET 4297
Ali Alismail
1/1
Calculation for the connecting tube:
Ti= Temperature of liquid inside Tube (K)
To= Temperature of liquid out side tube (K)
Di= diameter of tube (in) = 0.902 in
Do= diameter of Tube + isulator (in) = 1 in
L= 54 in
Wall = 0.049 in
L= 54 in
1"
To= 20 °C
Ti= 100 °C
0.902
Figure A-4

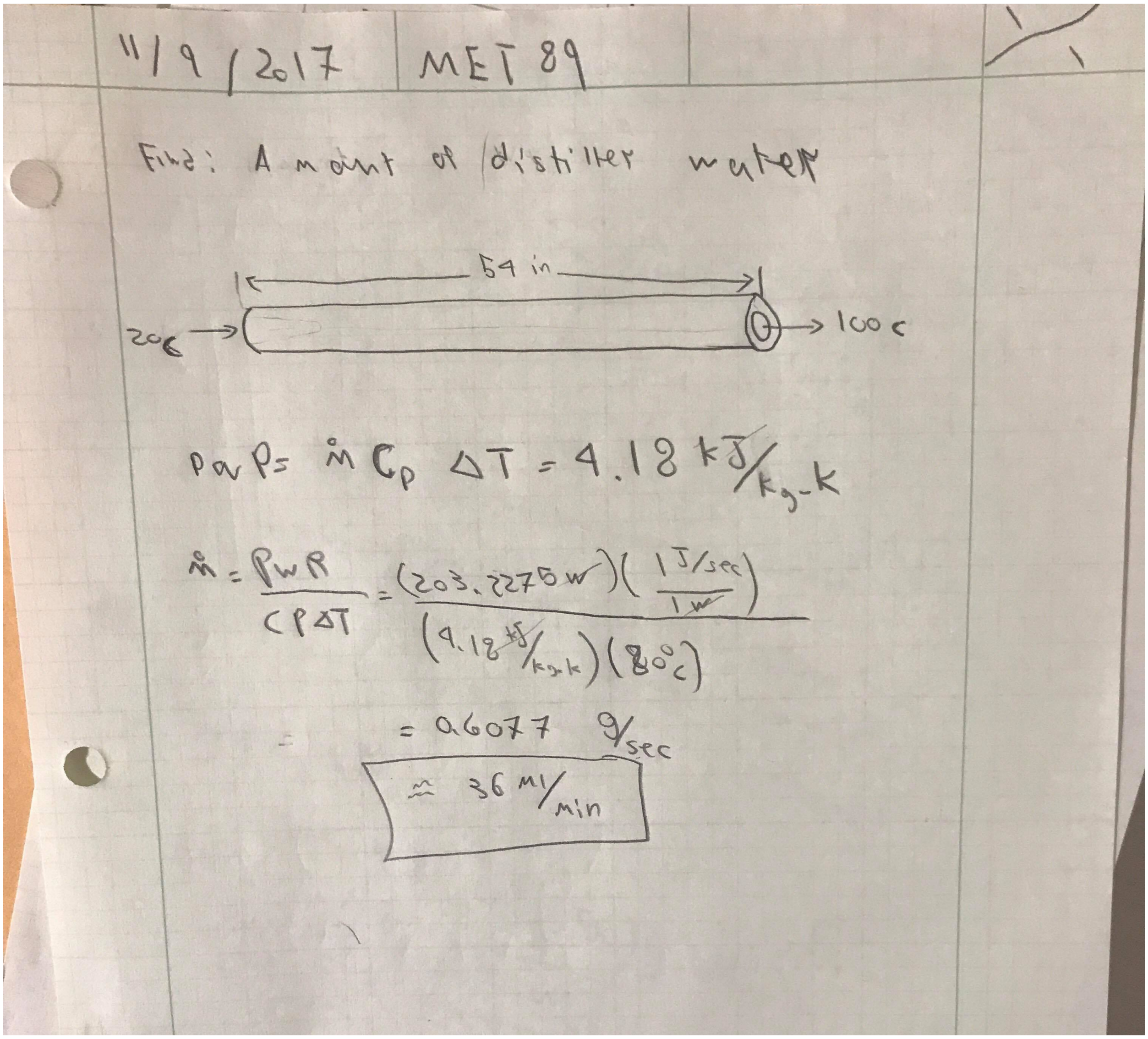

11/9/2017
MET 89
Find: A mount of distiller water
54 in
20c
100 c
P or P= ṁ Cp ΔT = 4.18 kJ/kg-k
ṁ = PwR / CPΔT = (203.2275 w)(1 J/sec / 1 w) / (4.18 kJ/kg-k)(80°c)
= 0.6077 g/sec
≈ 36 ml/min

Figure A-5

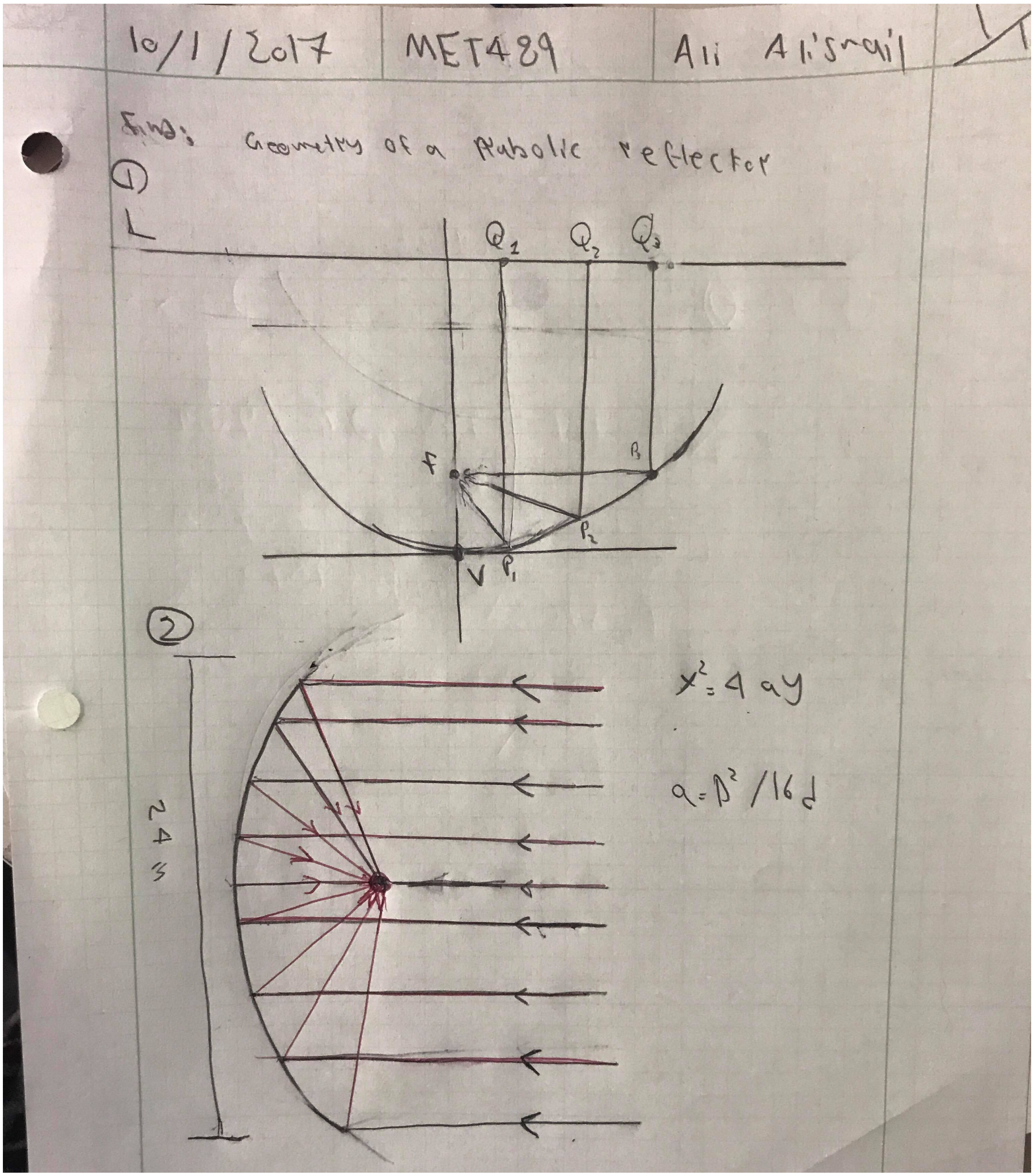
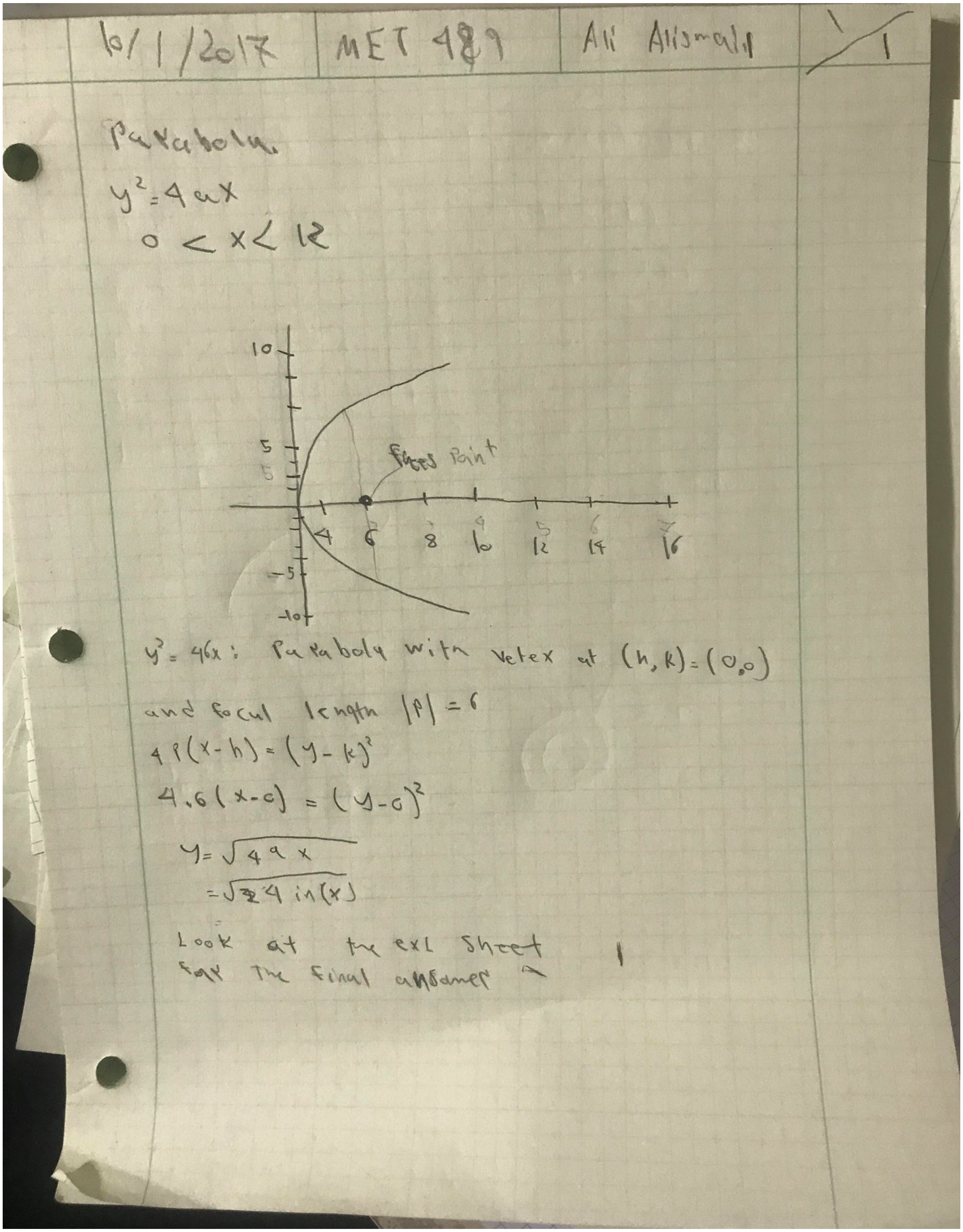

10/1/2017
MET489
Ali Alisma'il
Geometry of a Parabolic reflector
Q1
Q2
Q3
F
P1
P2
V
24 m
x² = 4ay
a = D² / 16d

Figure A-6



6/1/2017 | MET 489 | Ali Alismaili | 1/1

Parabola.

$y^2 = 4ax$

$0 < x < 12$

$y^2 = 46x$: Parabola with vetex at $(h,k) = (0,0)$

and focal length $|p| = 6$

$4p(x-h) = (y-k)^2$

$4.6(x-0) = (y-0)^2$

$y = \sqrt{4 \cdot 9 x}$

$= \sqrt{24 \text{ in}(x)}$

Look at the exl sheet for the final answer

Figure A-7

Parabola Calculation

focus a. =	6	inches
x value	y value	
0	0	
0.25	2.449489743	
0.5	3.464101615	
0.75	4.242640687	
1	4.898979486	
1.25	5.477225575	
1.5	6	
1.75	6.480740698	
2	6.92820323	
2.25	7.348469228	
2.5	7.745966692	
2.75	8.124038405	
3	8.485281374	
3.25	8.831760866	
3.5	9.16515139	
3.75	9.486832981	
4	9.797958971	
4.25	10.09950494	
4.5	10.39230485	
4.75	10.67707825	
5	10.95445115	
5.25	11.22497216	
5.5	11.48912529	
5.75	11.74734012	
6	12	

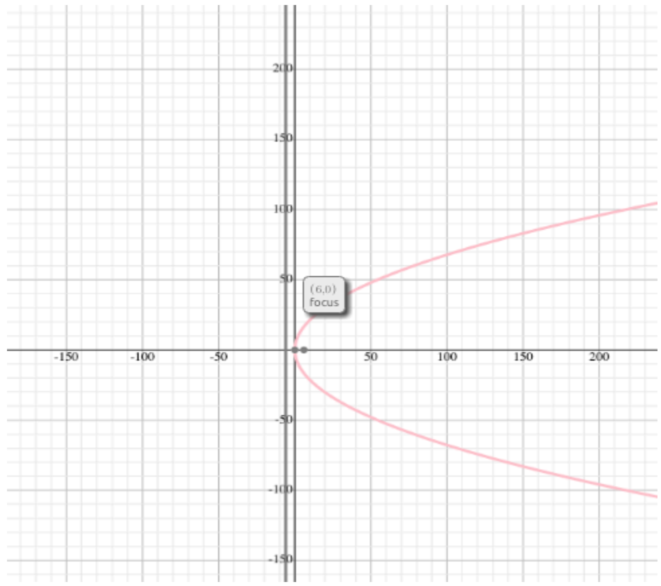
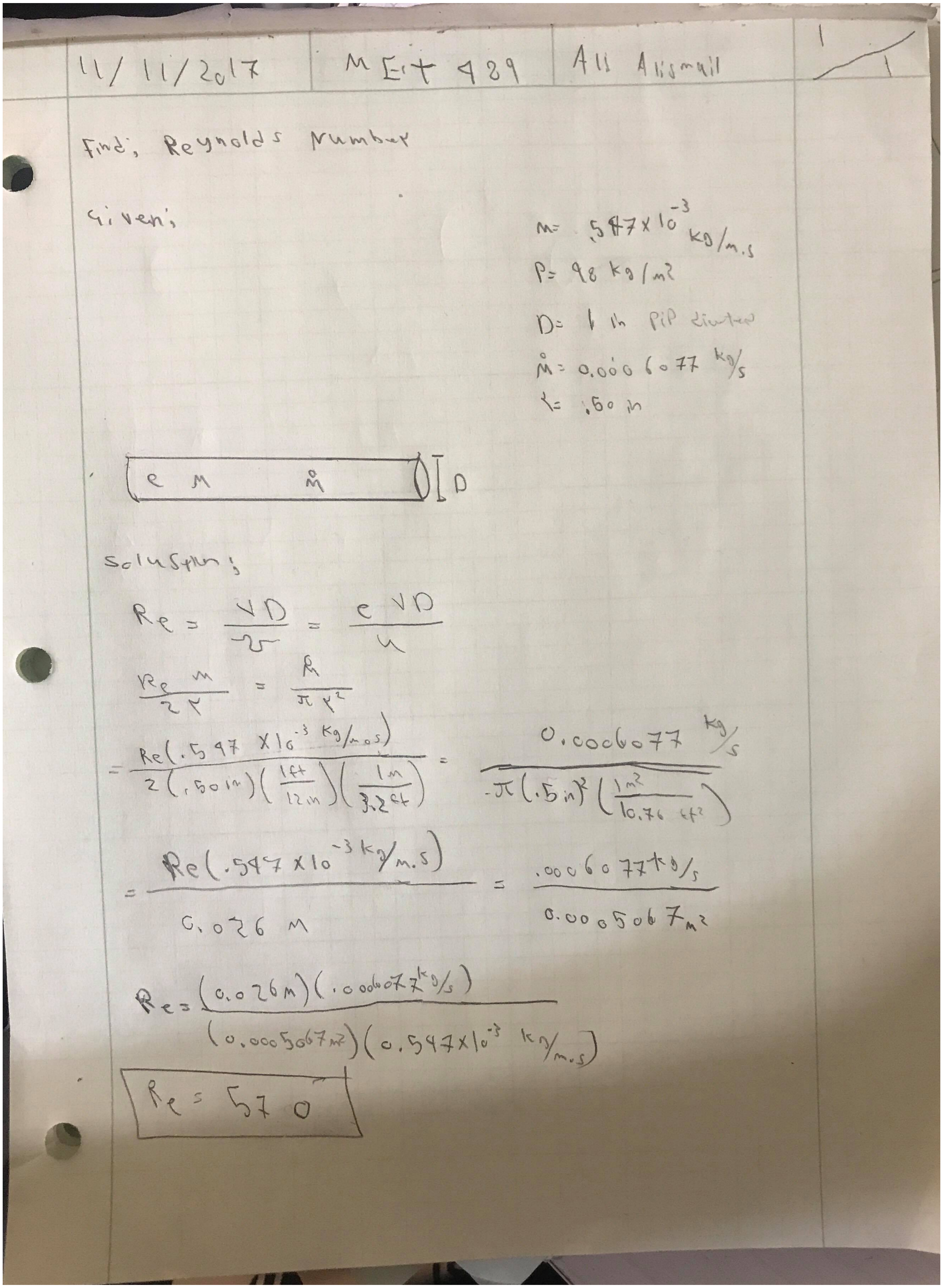


Figure A-8



11/11/2017 | MET 489 | Ali Alismail

Find; Reynolds Number

Given;

$\mu = .547 \times 10^{-3}$ kg/m.s

$\rho = 98$ kg/m³

D = 1 in pipe diameter

$\dot{m} = 0.0006077$ kg/s

r = .50 in

ρ μ ṁ D

Solution;

$$Re = \frac{VD}{\nu} = \frac{\rho V D}{\mu}$$

$$\frac{Re\,\mu}{2r} = \frac{\dot{m}}{\pi r^2}$$

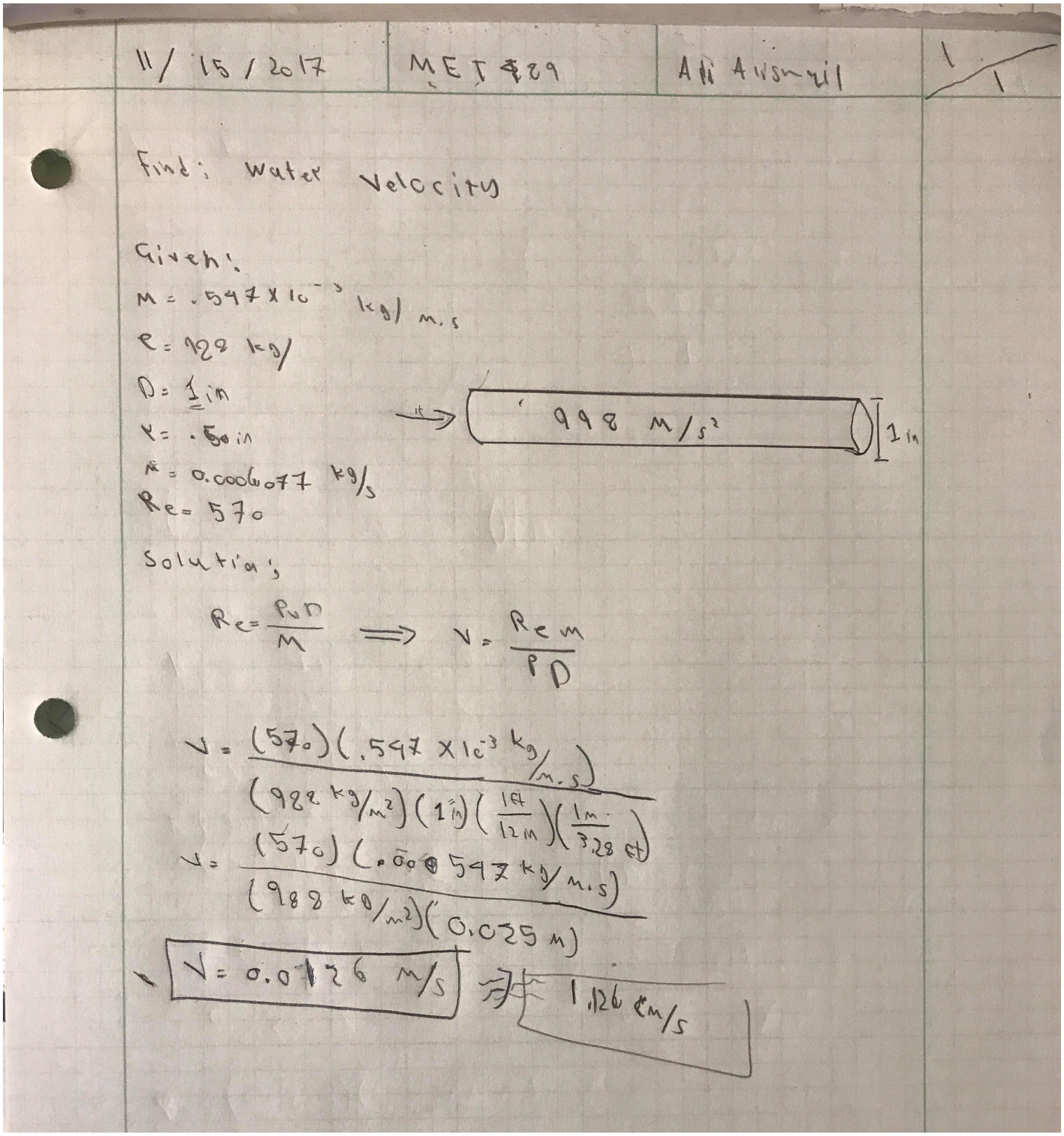
$$= \frac{Re(.547 \times 10^{-3}\ kg/m.s)}{2(.50\,in)\left(\frac{1ft}{12in}\right)\left(\frac{1m}{3.2ft}\right)} = \frac{0.0006077\ kg/s}{\pi(.5\,in)^2\left(\frac{1m^2}{10.76\,ft^2}\right)}$$

$$= \frac{Re(.547 \times 10^{-3}\ kg/m.s)}{0.026\ m} = \frac{.0006077\ kg/s}{0.0005067\ m^2}$$

$$Re = \frac{(0.026m)(.0006077\ kg/s)}{(0.0005067\ m^2)(0.547 \times 10^{-3}\ kg/m.s)}$$

Re = 570

Figure A-9



11/15/2017 | MET 489 | Ali Aismail

Find: water velocity

Given:

$\mu = .547 \times 10^{-3}$ kg/m.s

$\rho = 988$ kg/

$D = 1$ in

$r = .5$ in

$\dot{m} = 0.0006077$ kg/s

$Re = 570$

Solution:

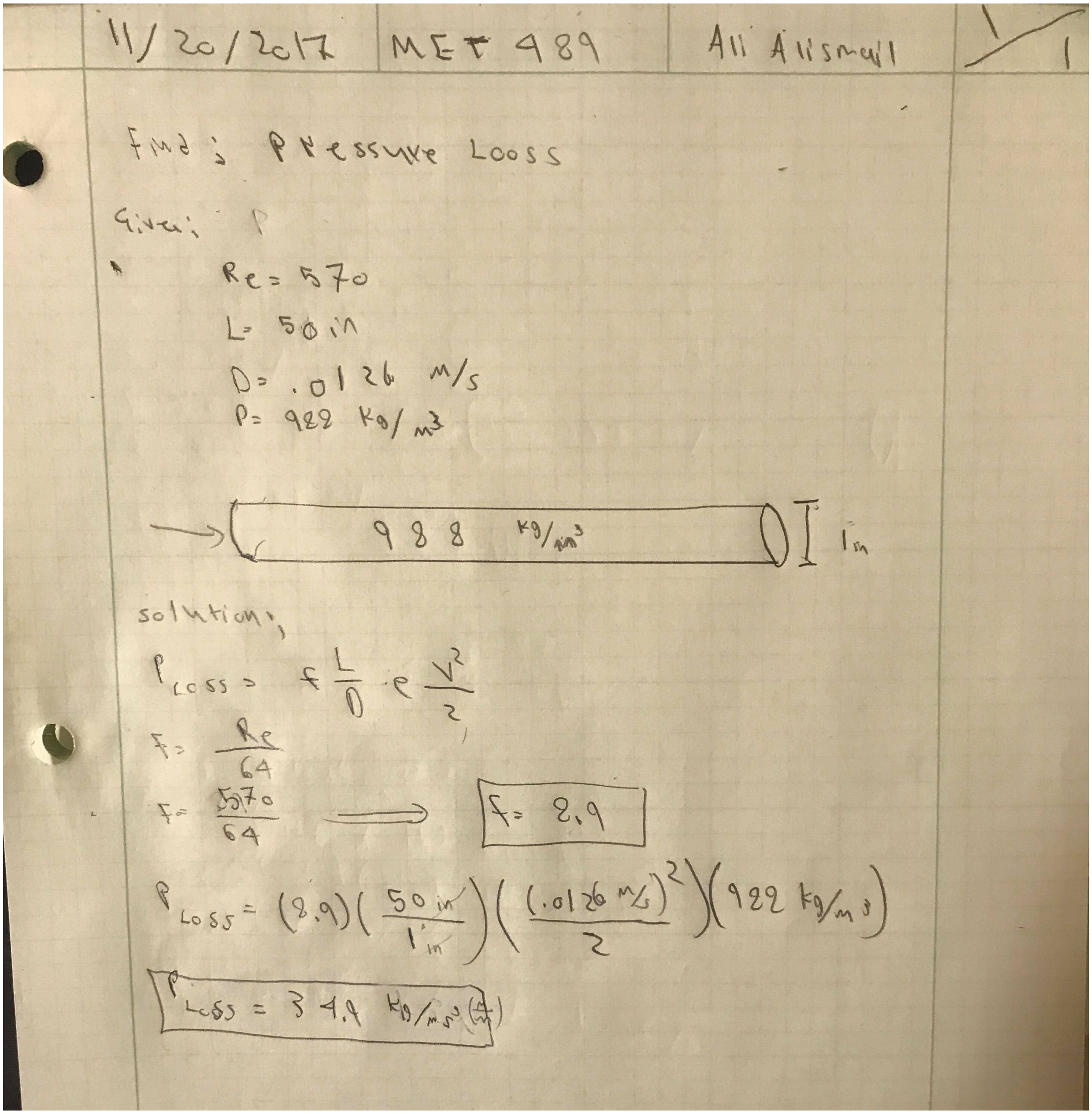
$Re = \frac{\rho v D}{\mu} \Rightarrow v = \frac{Re\,\mu}{\rho D}$

$v = \frac{(570)(.547 \times 10^{-3}\ kg/m.s)}{(988\ kg/m^2)(1\ in)\left(\frac{1\ ft}{12\ in}\right)\left(\frac{1\ m}{3.28\ ft}\right)}$

$v = \frac{(570)(.000547\ kg/m.s)}{(988\ kg/m^2)(0.025\ m)}$

$V = 0.0126$ m/s ⇒ 1.26 cm/s

Figure A-10


11/20/2017 | MET 489 | Ali Alismail | 1/1

Find: Pressure Looss

Given:

Re = 570

L = 50 in

D = .0126 m/s

ρ = 988 kg/m³

→ 988 kg/m³ | 1 in

solution:

$P_{LOSS} = f \frac{L}{D} \rho \frac{V^2}{2}$

$f = \frac{Re}{64}$

$f = \frac{570}{64}$ ⟹ $f = 8.9$

$P_{LOSS} = (8.9)\left(\frac{50\ in}{1\ in}\right)\left(\frac{(.0126\ m/s)^2}{2}\right)(988\ kg/m^3)$

$P_{LOSS} = 34.9\ kg/m s^2\ (\frac{N}{m^2})$

Figure A-11

APPENDIX (B) – Drawing

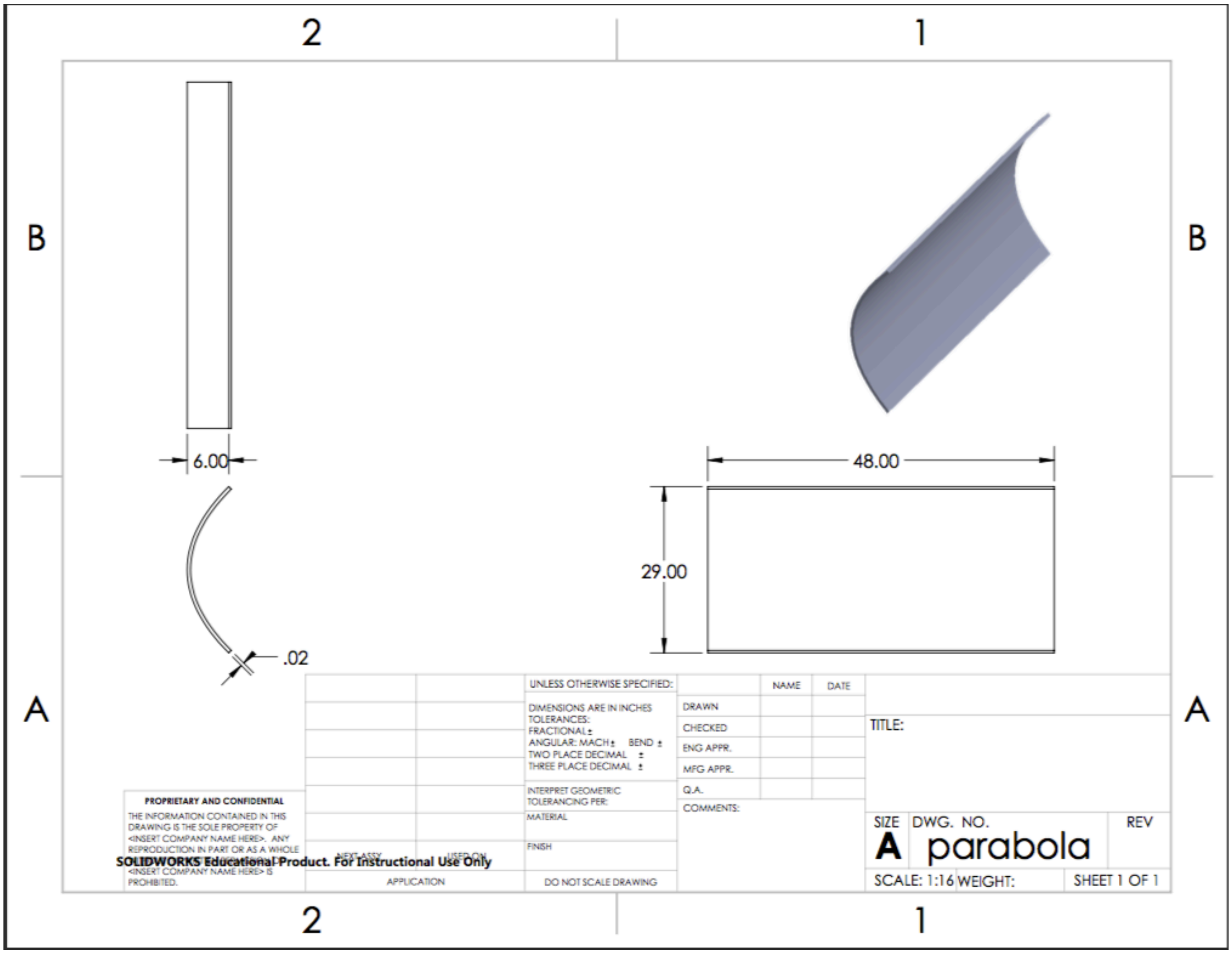
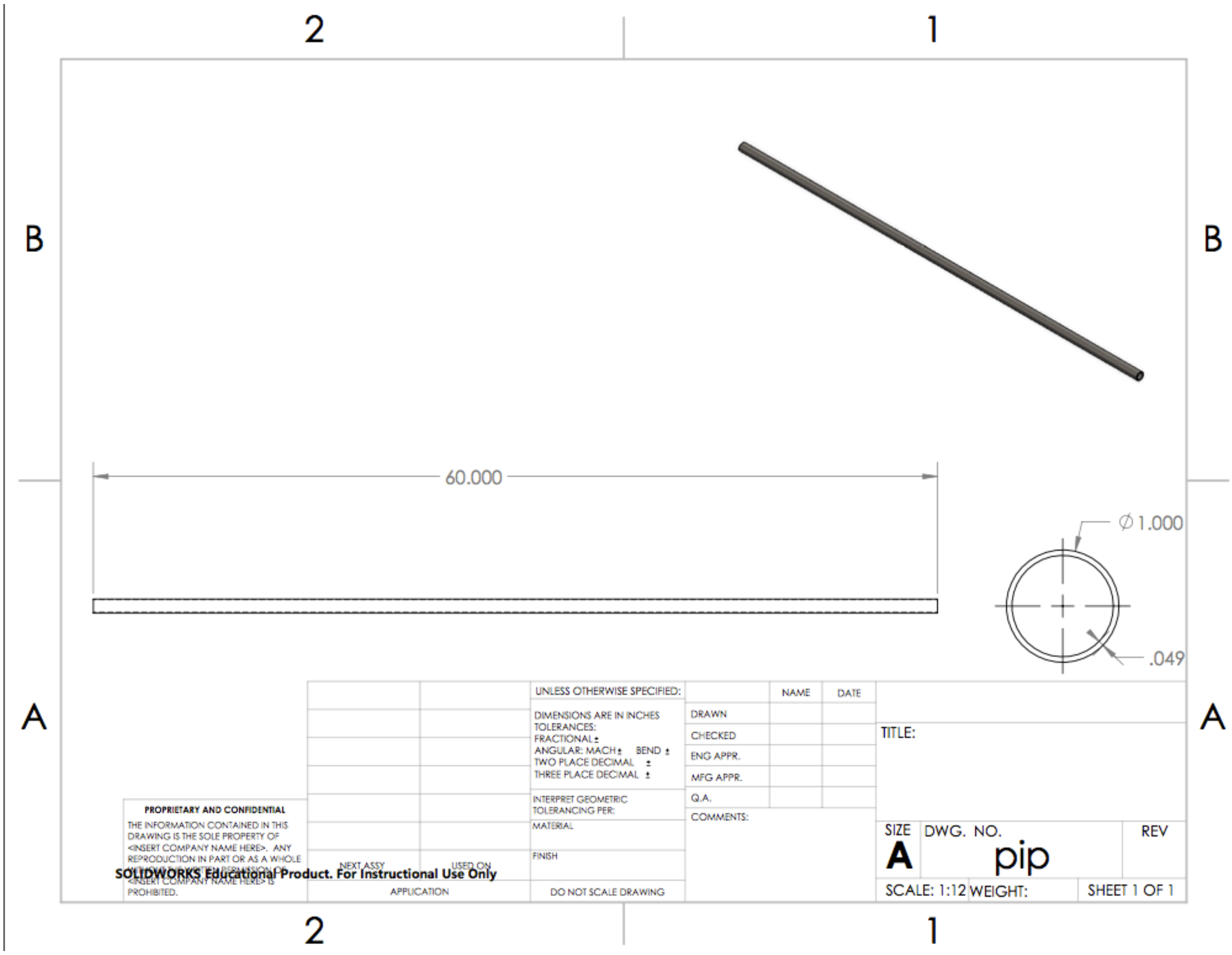


Figure B-1



60.000
Ø1.000
.049
UNLESS OTHERWISE SPECIFIED:
DIMENSIONS ARE IN INCHES
TOLERANCES:
FRACTIONAL ±
ANGULAR: MACH ± BEND ±
TWO PLACE DECIMAL ±
THREE PLACE DECIMAL ±
INTERPRET GEOMETRIC TOLERANCING PER:
MATERIAL
FINISH
DO NOT SCALE DRAWING
NAME
DATE
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CHECKED
ENG APPR.
MFG APPR.
Q.A.
COMMENTS:
TITLE:
SIZE
A
DWG. NO.
pip
REV
SCALE: 1:12
WEIGHT:
SHEET 1 OF 1
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NEXT ASSY
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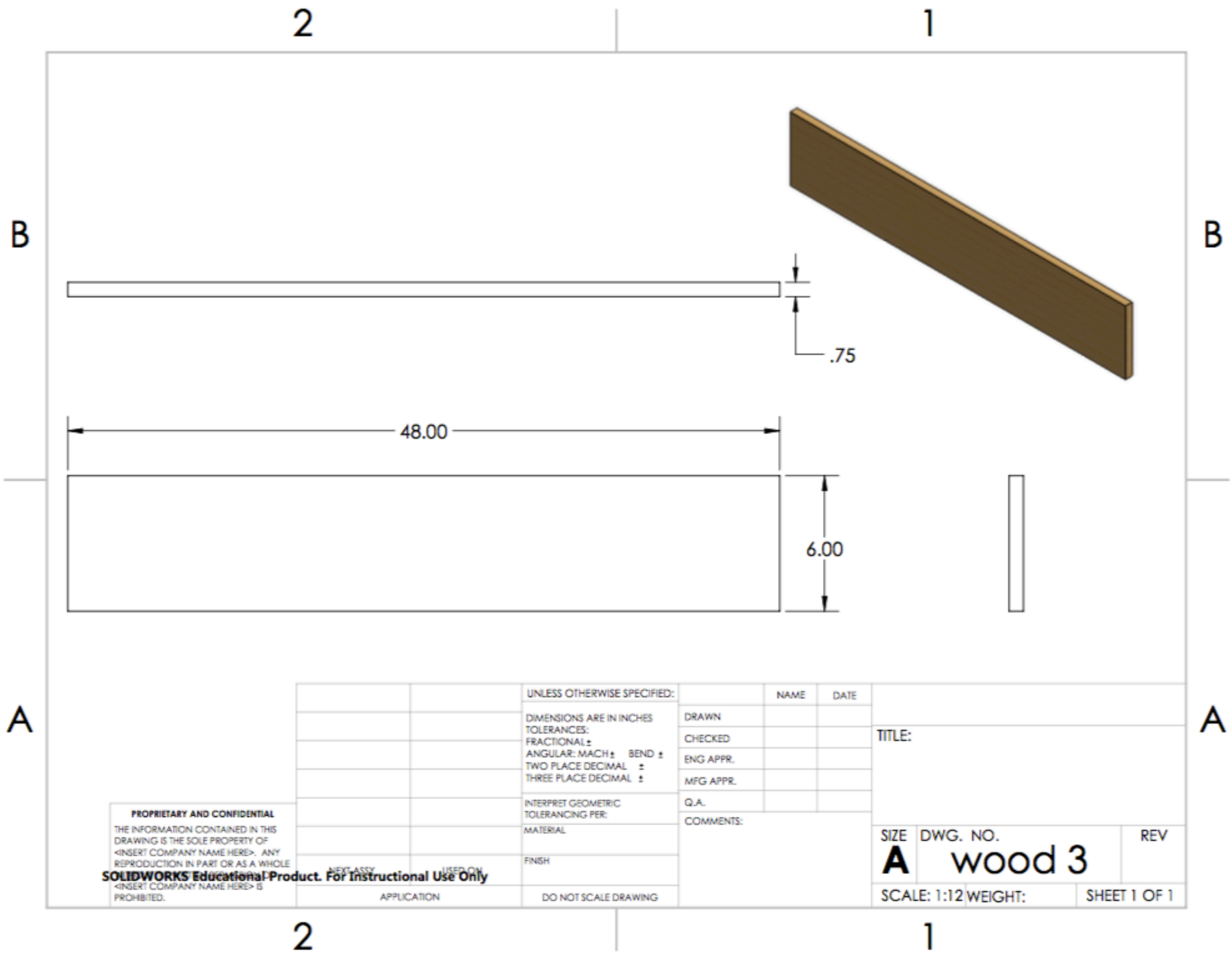
Figure B-2



2
1
B
B
A
A
.75
48.00
6.00
UNLESS OTHERWISE SPECIFIED:
NAME
DATE
DIMENSIONS ARE IN INCHES
TOLERANCES:
FRACTIONAL ±
ANGULAR: MACH ± BEND ±
TWO PLACE DECIMAL ±
THREE PLACE DECIMAL ±
DRAWN
CHECKED
ENG APPR.
MFG APPR.
Q.A.
COMMENTS:
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REV
A
wood 3
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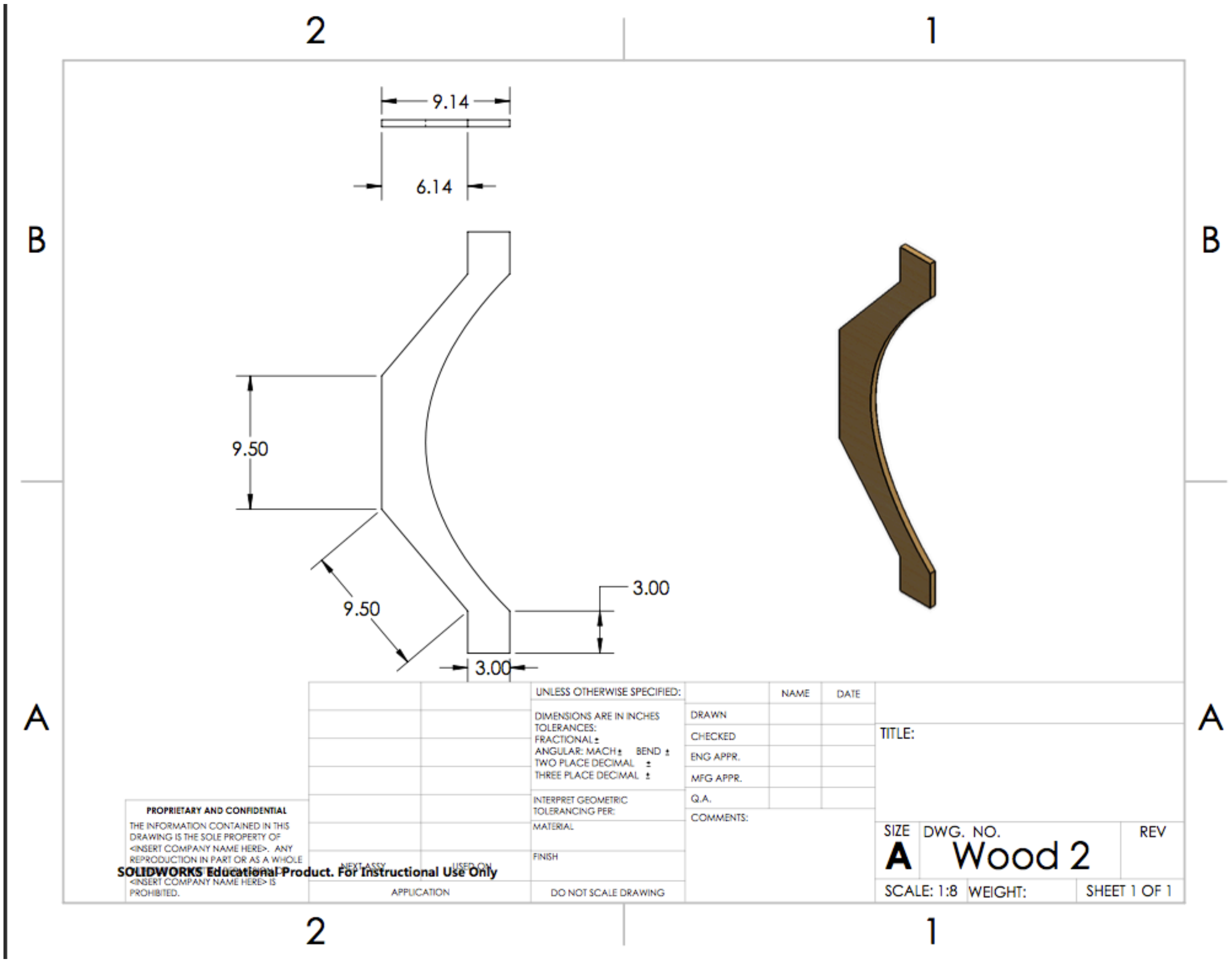
WEIGHT:
SHEET 1 OF 1
2
1

Figure B-3



9.14
6.14
9.50
9.50
3.00
3.00
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FRACTIONAL±
ANGULAR: MACH± BEND ±
TWO PLACE DECIMAL ±
THREE PLACE DECIMAL ±
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DATE
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CHECKED
ENG APPR.
MFG APPR.
Q.A.
COMMENTS:
TITLE:
SIZE
A
DWG. NO.
Wood 2
REV
SCALE: 1:8
WEIGHT:
SHEET 1 OF 1
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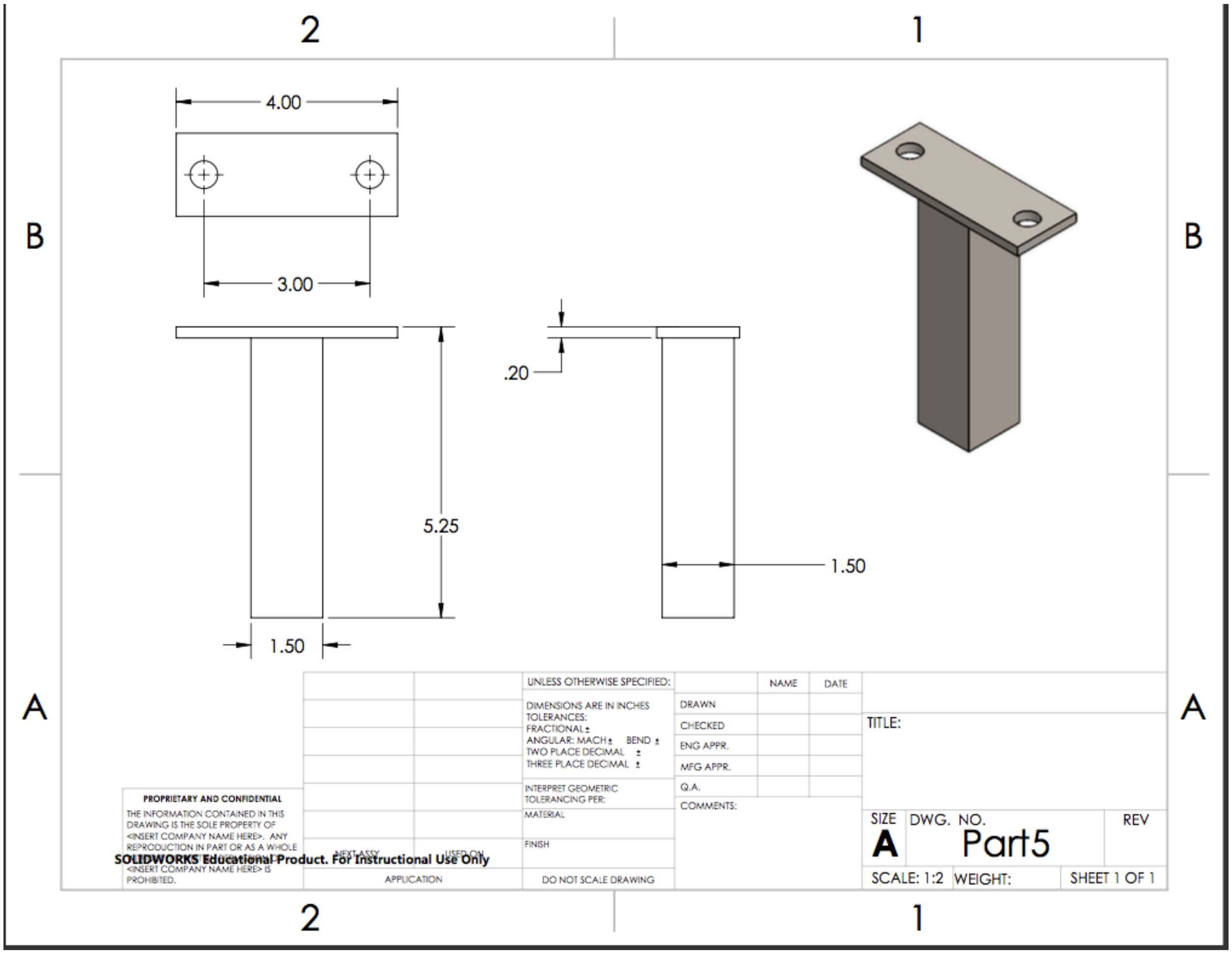
Figure B-4


4.00
3.00
.20
5.25
1.50
1.50
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ANGULAR: MACH ± BEND ±
TWO PLACE DECIMAL ±
THREE PLACE DECIMAL ±
INTERPRET GEOMETRIC TOLERANCING PER:
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CHECKED
ENG APPR.
MFG APPR.
Q.A.
COMMENTS:
TITLE:
SIZE
A
DWG. NO.
Part5
REV
SCALE: 1:2
WEIGHT:
SHEET 1 OF 1
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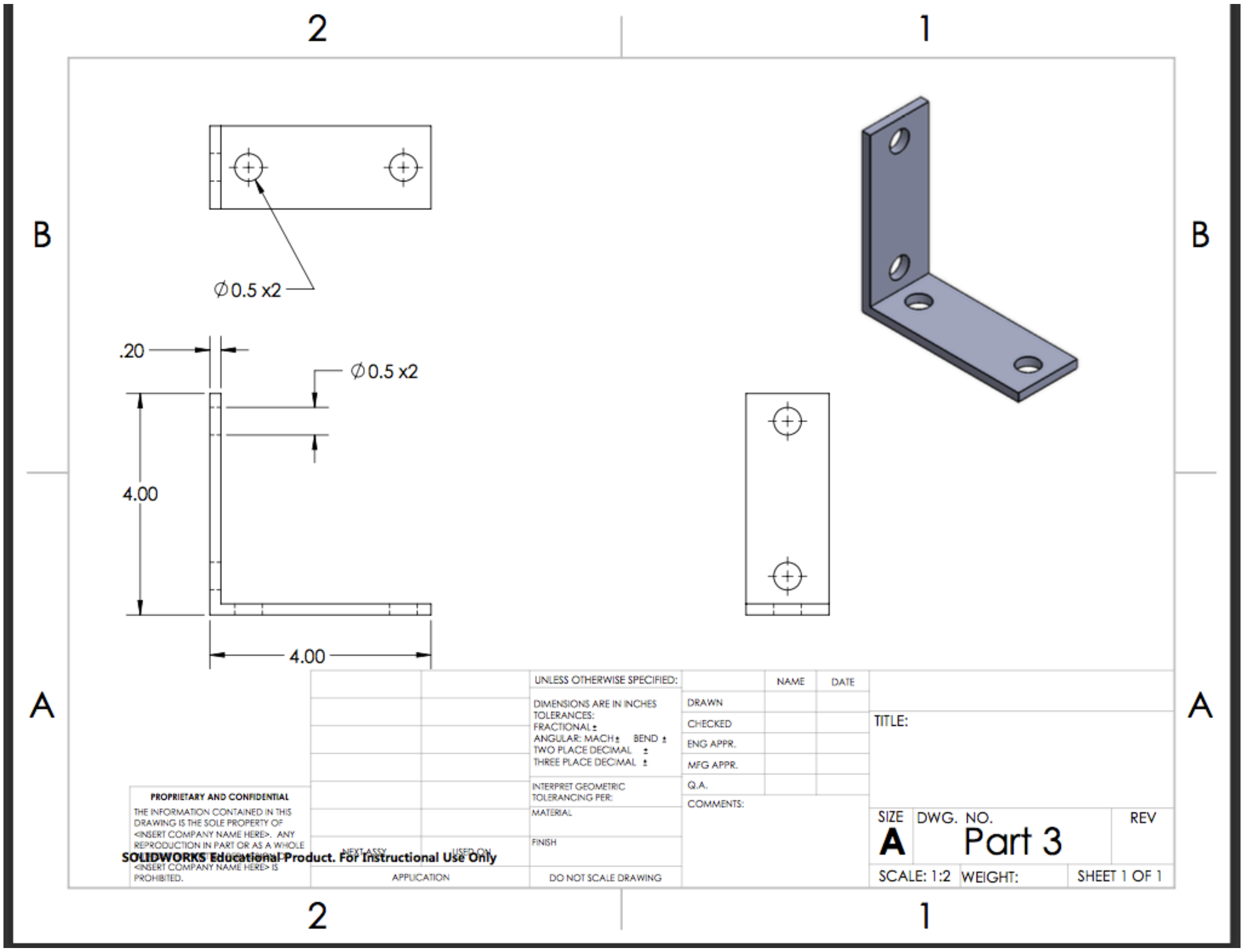
Figure B-5



2
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B
A
∅0.5 x2
.20
∅0.5 x2
4.00
4.00
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TOLERANCES:
FRACTIONAL ±
ANGULAR: MACH ± BEND ±
TWO PLACE DECIMAL ±
THREE PLACE DECIMAL ±
INTERPRET GEOMETRIC TOLERANCING PER:
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ENG APPR.
MFG APPR.
Q.A.
COMMENTS:
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DWG. NO.
Part 3
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WEIGHT:
SHEET 1 OF 1
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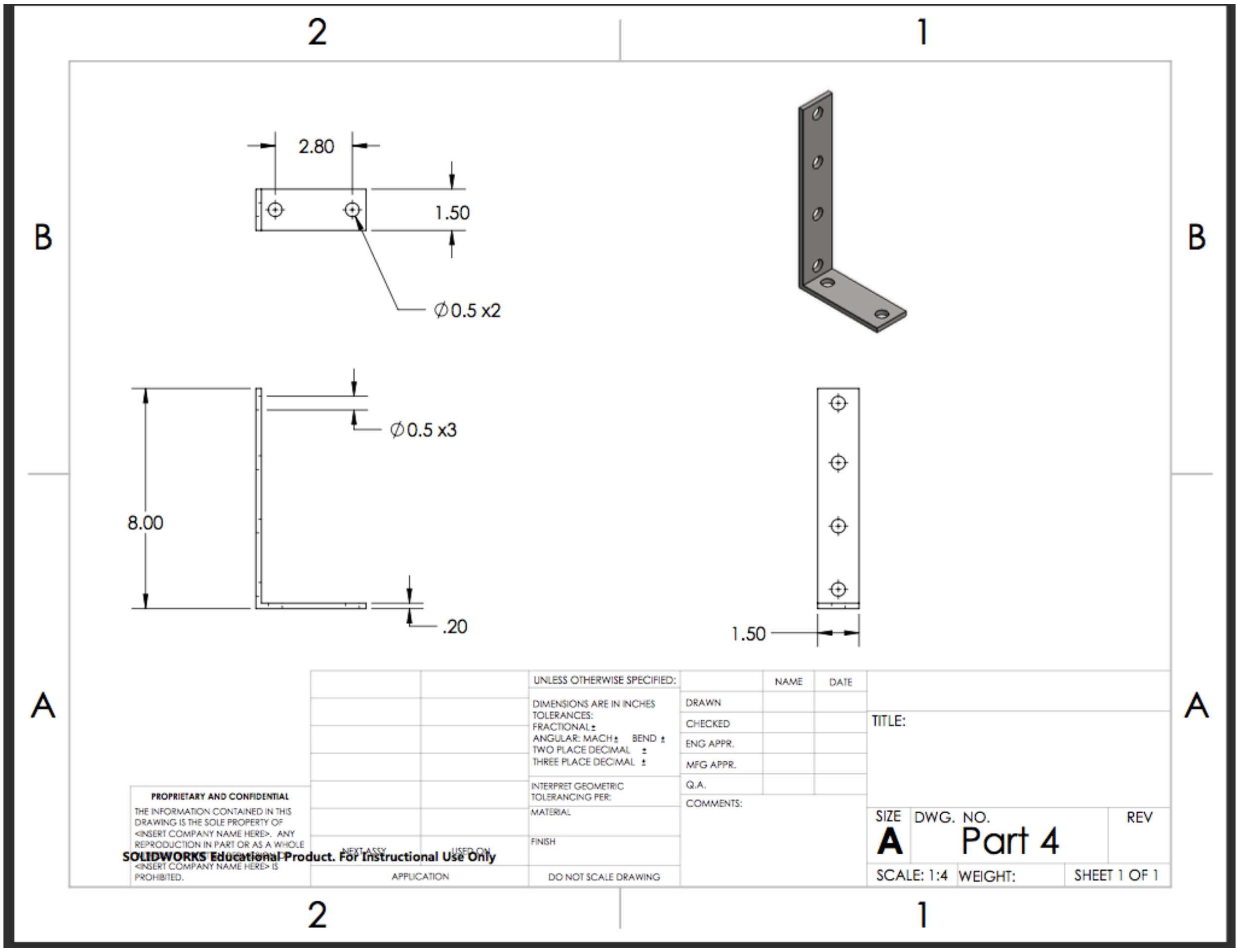
Figure B-6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1.50
∅0.5 x2
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8.00
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1.50
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DATE
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FRACTIONAL±
ANGULAR: MACH± BEND ±
TWO PLACE DECIMAL ±
THREE PLACE DECIMAL ±
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MFG APPR.
Q.A.
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Part 4
REV
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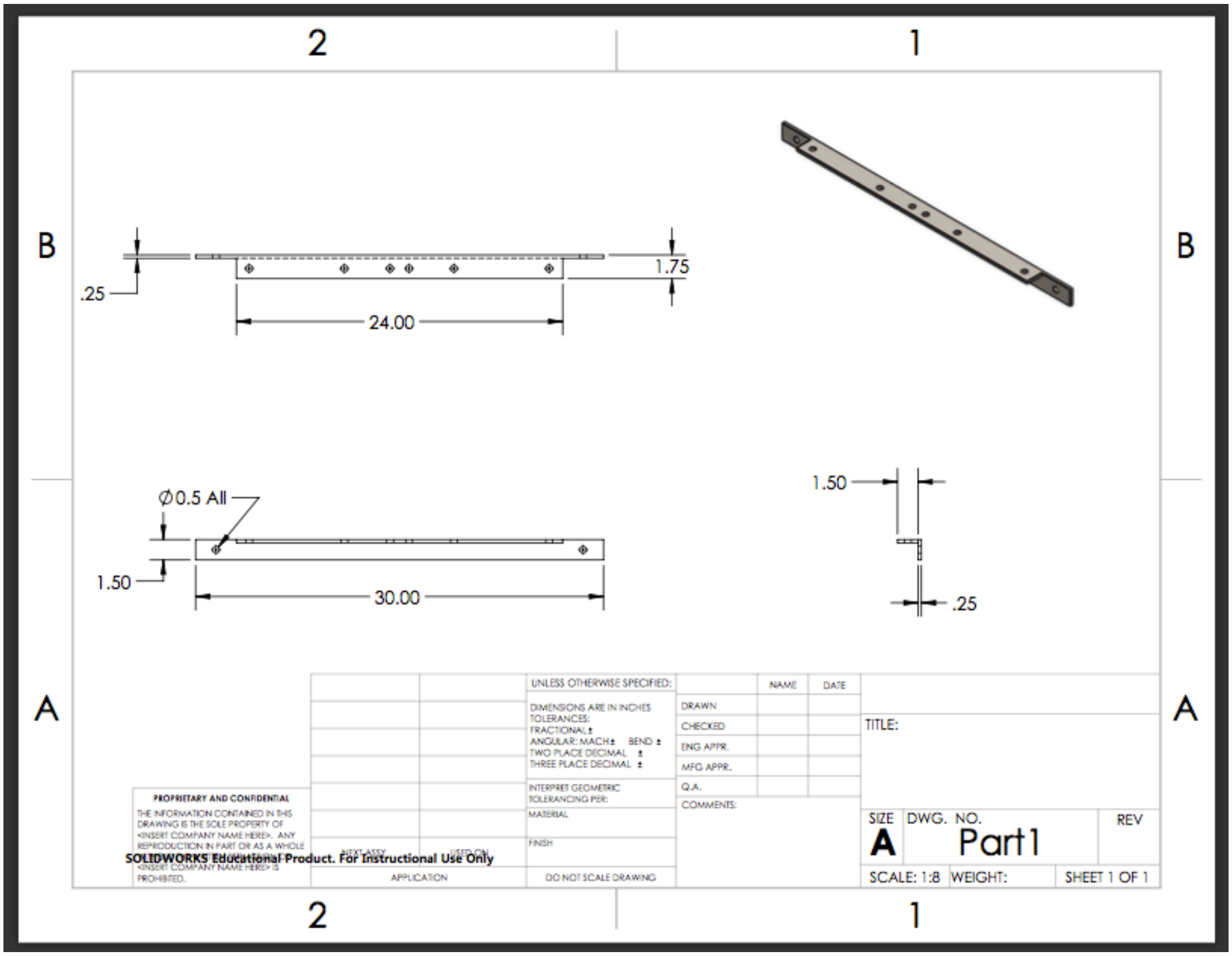
WEIGHT:
SHEET 1 OF 1

Figure B-7


2
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B
B
A
A
.25
1.75
24.00
Ø0.5 All
1.50
30.00
1.50
.25
UNLESS OTHERWISE SPECIFIED:
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DIMENSIONS ARE IN INCHES
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FRACTIONAL ±
ANGULAR: MACH ± BEND ±
TWO PLACE DECIMAL ±
THREE PLACE DECIMAL ±
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MFG APPR.
Q.A.
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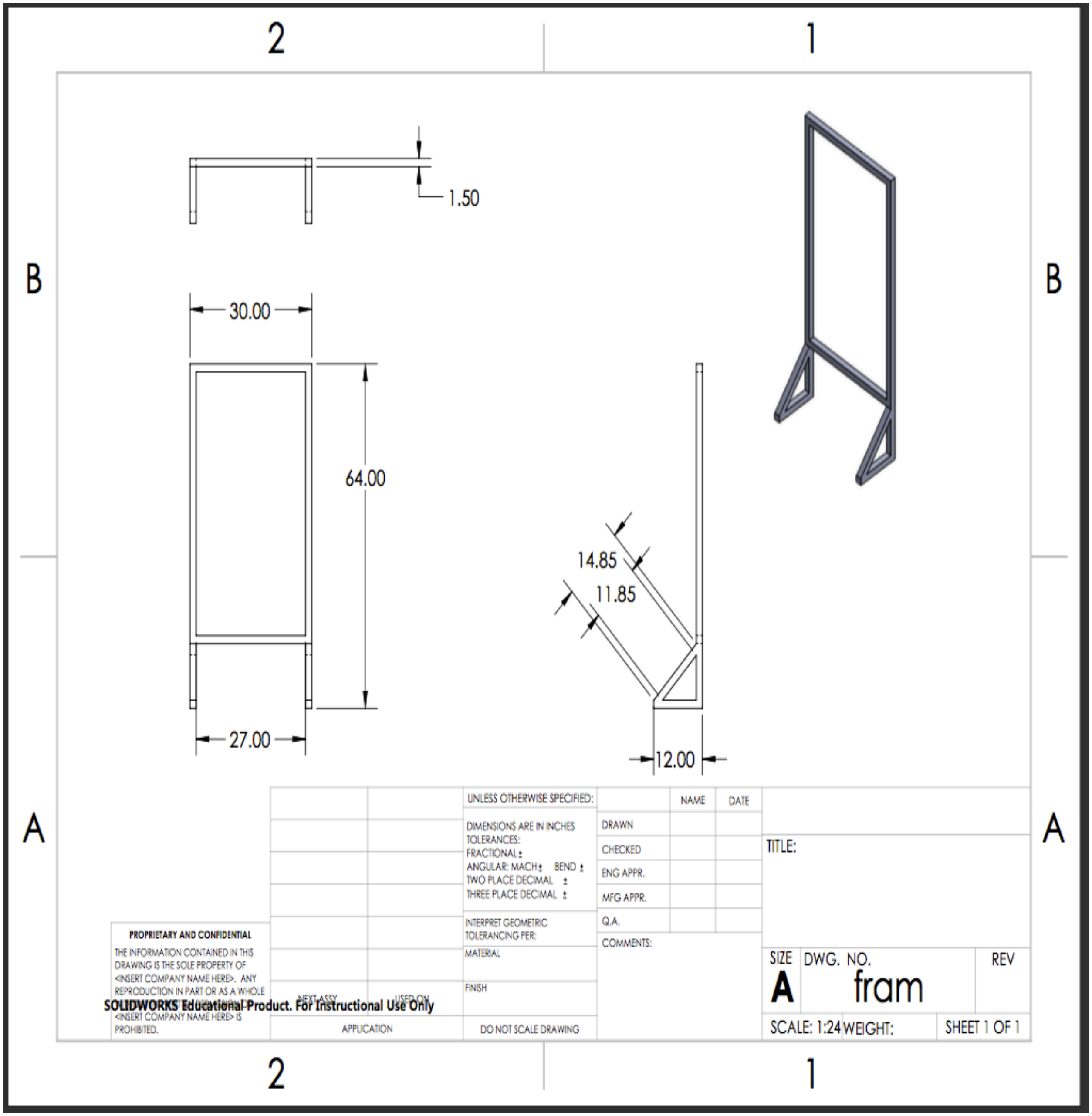
Figure B-8



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ANGULAR: MACH± BEND ±
TWO PLACE DECIMAL ±
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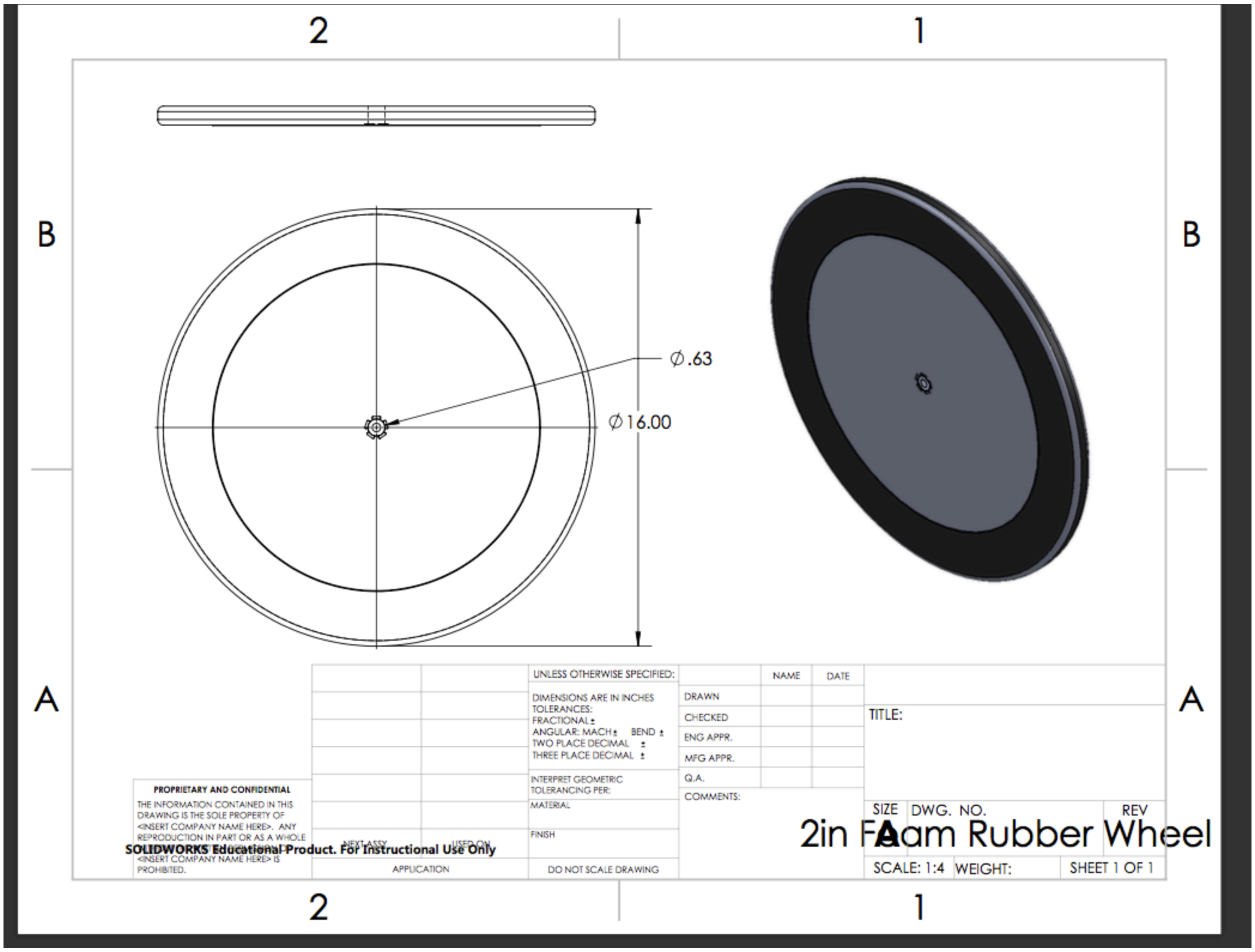
Figure B-9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ANGULAR: MACH ± BEND ±
TWO PLACE DECIMAL ±
THREE PLACE DECIMAL ±
INTERPRET GEOMETRIC TOLERANCING PER:
MATERIAL
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Q.A.
COMMENTS:
TITLE:
SIZE
DWG. NO.
REV
A
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WEIGHT:
SHEET 1 OF 1
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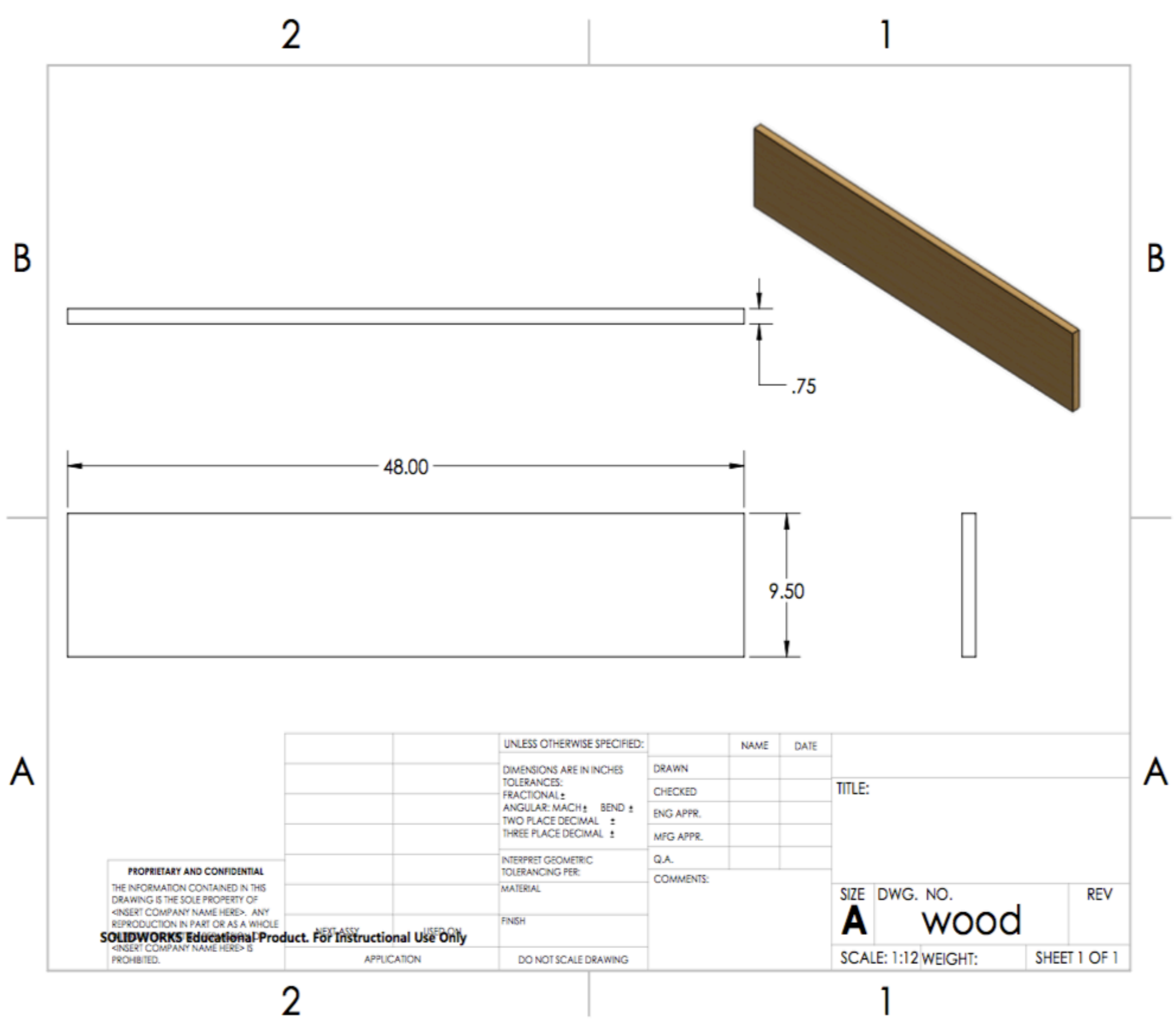

2
1
B
A
.75
48.00
9.50
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NAME
DATE
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TOLERANCES:
FRACTIONAL±
ANGULAR: MACH± BEND ±
TWO PLACE DECIMAL ±
THREE PLACE DECIMAL ±
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CHECKED
ENG APPR.
MFG APPR.
Q.A.
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SIZE
A
DWG. NO.
wood
REV
SCALE: 1:12
WEIGHT:
SHEET 1 OF 1
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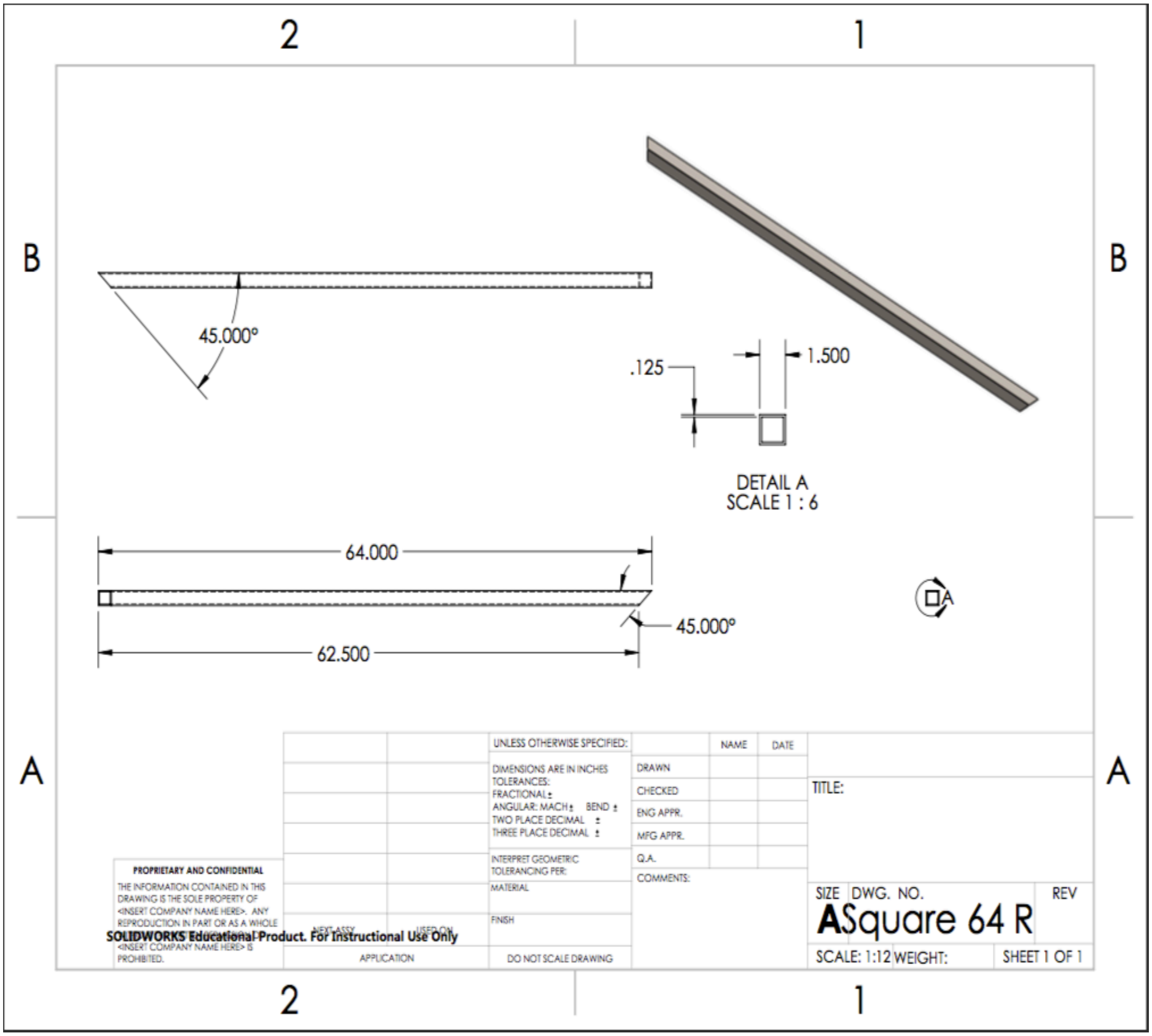
Figure B-11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.125
1.500
DETAIL A
SCALE 1 : 6
64.000
45.000°
62.500
A
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TOLERANCES:
FRACTIONAL±
ANGULAR: MACH± BEND ±
TWO PLACE DECIMAL ±
THREE PLACE DECIMAL ±
INTERPRET GEOMETRIC
TOLERANCING PER:
MATERIAL
FINISH
DO NOT SCALE DRAWING
NAME
DATE
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CHECKED
ENG APPR.
MFG APPR.
Q.A.
COMMENTS:
TITLE:
SIZE DWG. NO.
REV
A Square 64 R
SCALE: 1:12 WEIGHT:
SHEET 1 OF 1
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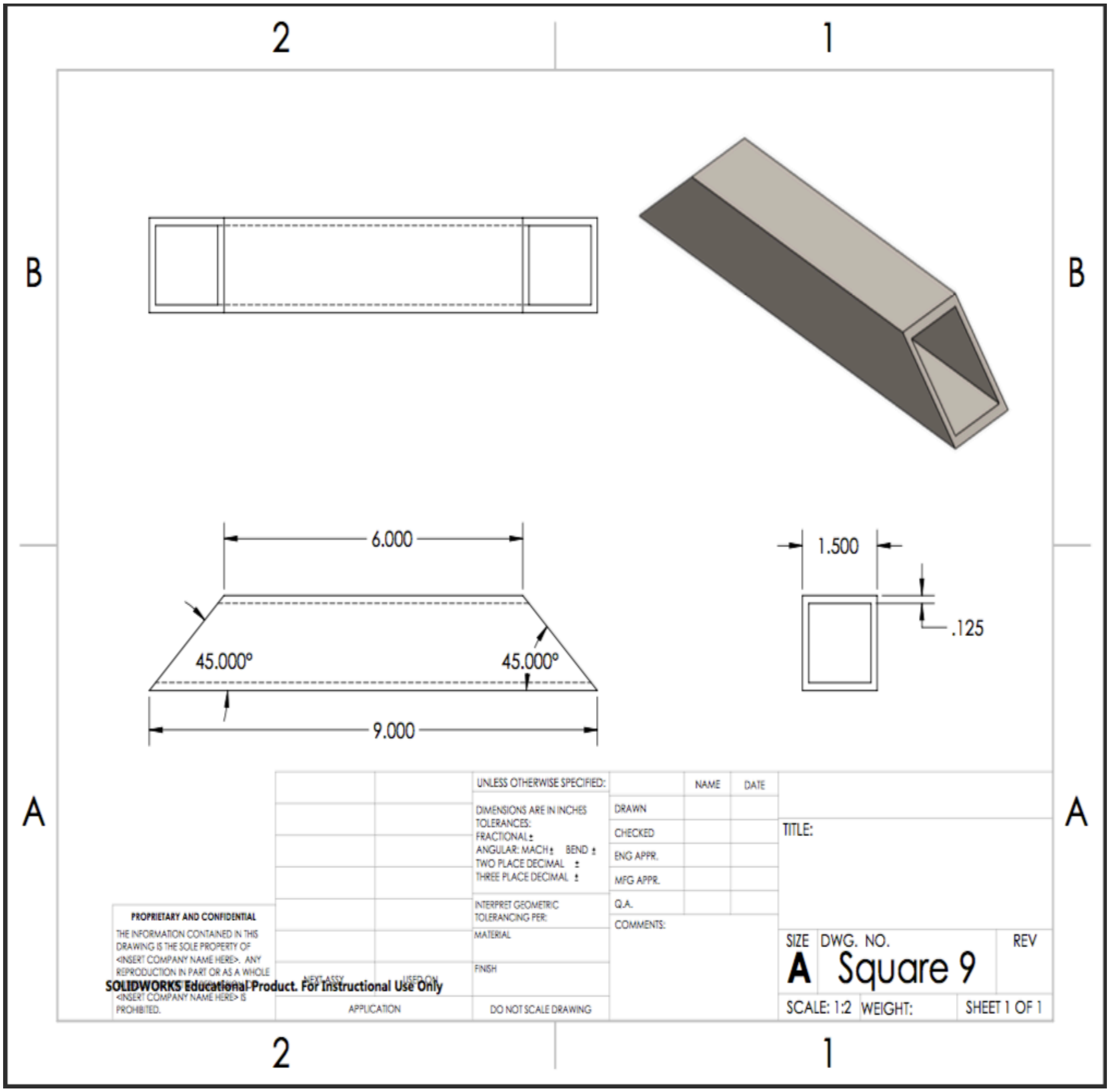
Figure B-12



6.000
9.000
45.000°
45.000°
1.500
.125
UNLESS OTHERWISE SPECIFIED:
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TOLERANCES:
FRACTIONAL ±
ANGULAR: MACH ± BEND ±
TWO PLACE DECIMAL ±
THREE PLACE DECIMAL ±
INTERPRET GEOMETRIC TOLERANCING PER:
MATERIAL
FINISH
NAME
DATE
DRAWN
CHECKED
ENG APPR.
MFG APPR.
Q.A.
COMMENTS:
TITLE:
SIZE DWG. NO.
REV
A Square 9
SCALE: 1:2 WEIGHT:
SHEET 1 OF 1
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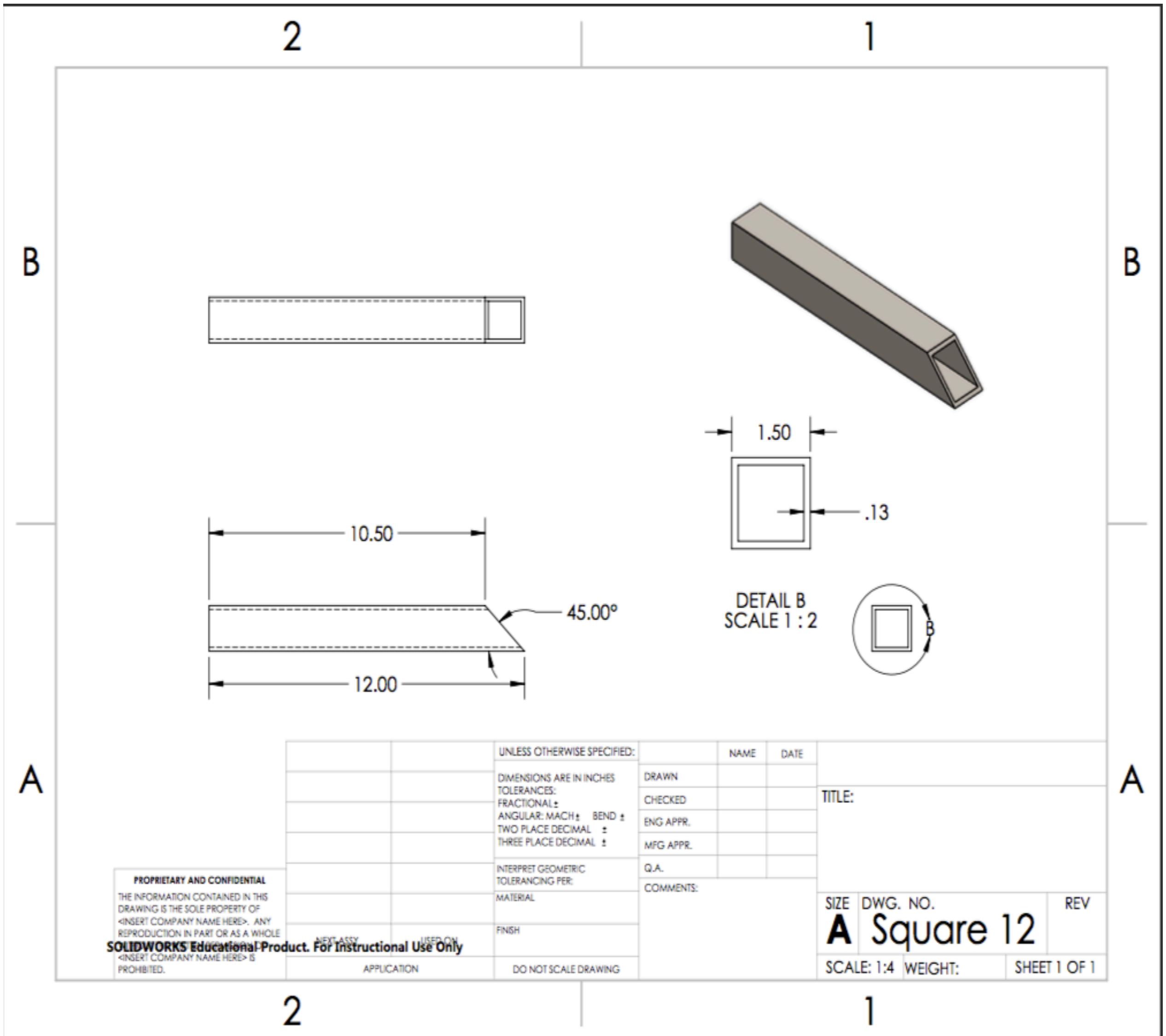
Figure B-13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1
B
B
10.50
45.00°
12.00
1.50
.13
DETAIL B
SCALE 1 : 2
A
A
UNLESS OTHERWISE SPECIFIED:
DIMENSIONS ARE IN INCHES
TOLERANCES:
FRACTIONAL ±
ANGULAR: MACH ± BEND ±
TWO PLACE DECIMAL ±
THREE PLACE DECIMAL ±
INTERPRET GEOMETRIC TOLERANCING PER:
MATERIAL
FINISH
DO NOT SCALE DRAWING
NAME
DATE
DRAWN
CHECKED
ENG APPR.
MFG APPR.
Q.A.
COMMENTS:
TITLE:
SIZE
DWG. NO.
REV
A
Square 12
SCALE: 1:4
WEIGHT:
SHEET 1 OF 1
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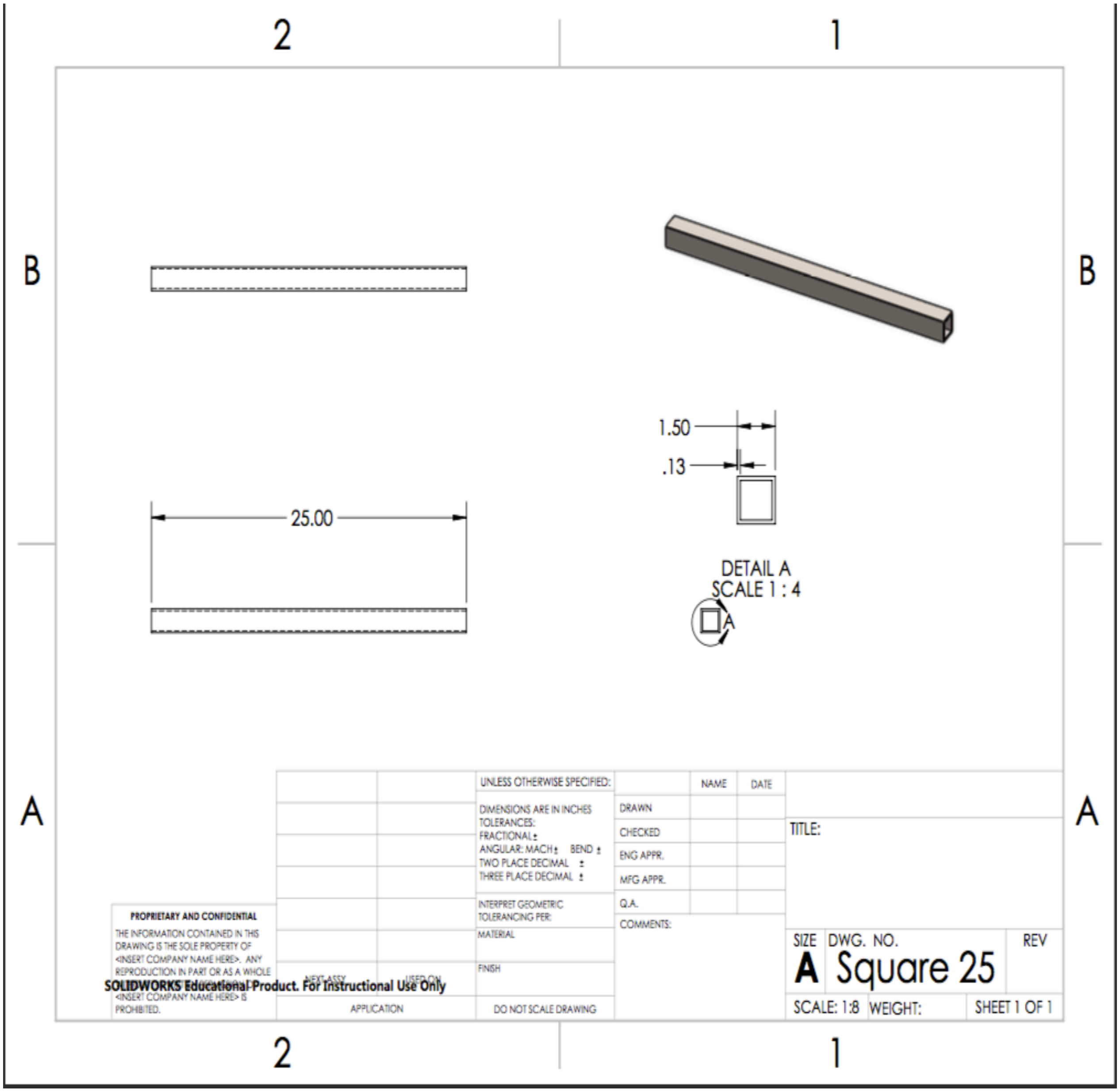
APPLICATION
2
1

Figure B-14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25.00
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DETAIL A
SCALE 1 : 4
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TOLERANCES:
FRACTIONAL±
ANGULAR: MACH± BEND ±
TWO PLACE DECIMAL ±
THREE PLACE DECIMAL ±
INTERPRET GEOMETRIC TOLERANCING PER:
MATERIAL
FINISH
DO NOT SCALE DRAWING
NAME
DATE
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CHECKED
ENG APPR.
MFG APPR.
Q.A.
COMMENTS:
TITLE:
SIZE
DWG. NO.
REV
A
Square 25
SCALE: 1:8
WEIGHT:
SHEET 1 OF 1
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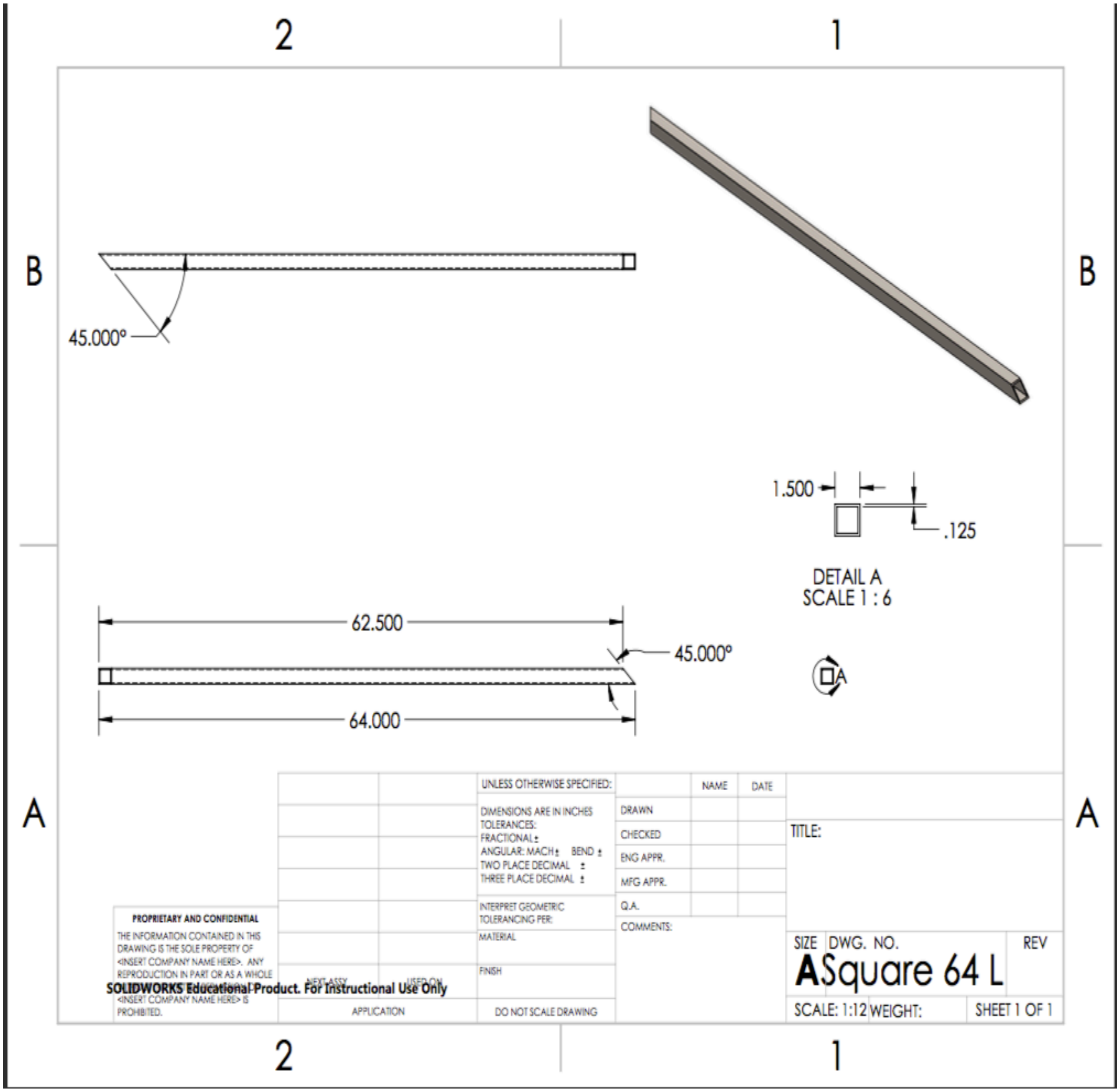
Figure B-15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62.500
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64.000
1.500
.125
DETAIL A
SCALE 1 : 6
A
UNLESS OTHERWISE SPECIFIED:
NAME
DATE
DIMENSIONS ARE IN INCHES
TOLERANCES:
FRACTIONAL ±
ANGULAR: MACH ± BEND ±
TWO PLACE DECIMAL ±
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ENG APPR.
MFG APPR.
Q.A.
COMMENTS:
INTERPRET GEOMETRIC TOLERANCING PER:
MATERIAL
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DO NOT SCALE DRAWING
APPLICATION
TITLE:
SIZE DWG. NO.
REV
A Square 64 L
SCALE: 1:12 WEIGHT:
SHEET 1 OF 1
PROPRIETARY AND CONFIDENTIAL
THE INFORMATION CONTAINED IN THIS DRAWING IS THE SOLE PROPERTY OF <INSERT COMPANY NAME HERE>. ANY REPRODUCTION IN PART OR AS A WHOLE WITHOUT THE WRITTEN PERMISSION OF <INSERT COMPANY NAME HERE> IS PROHIBITED.
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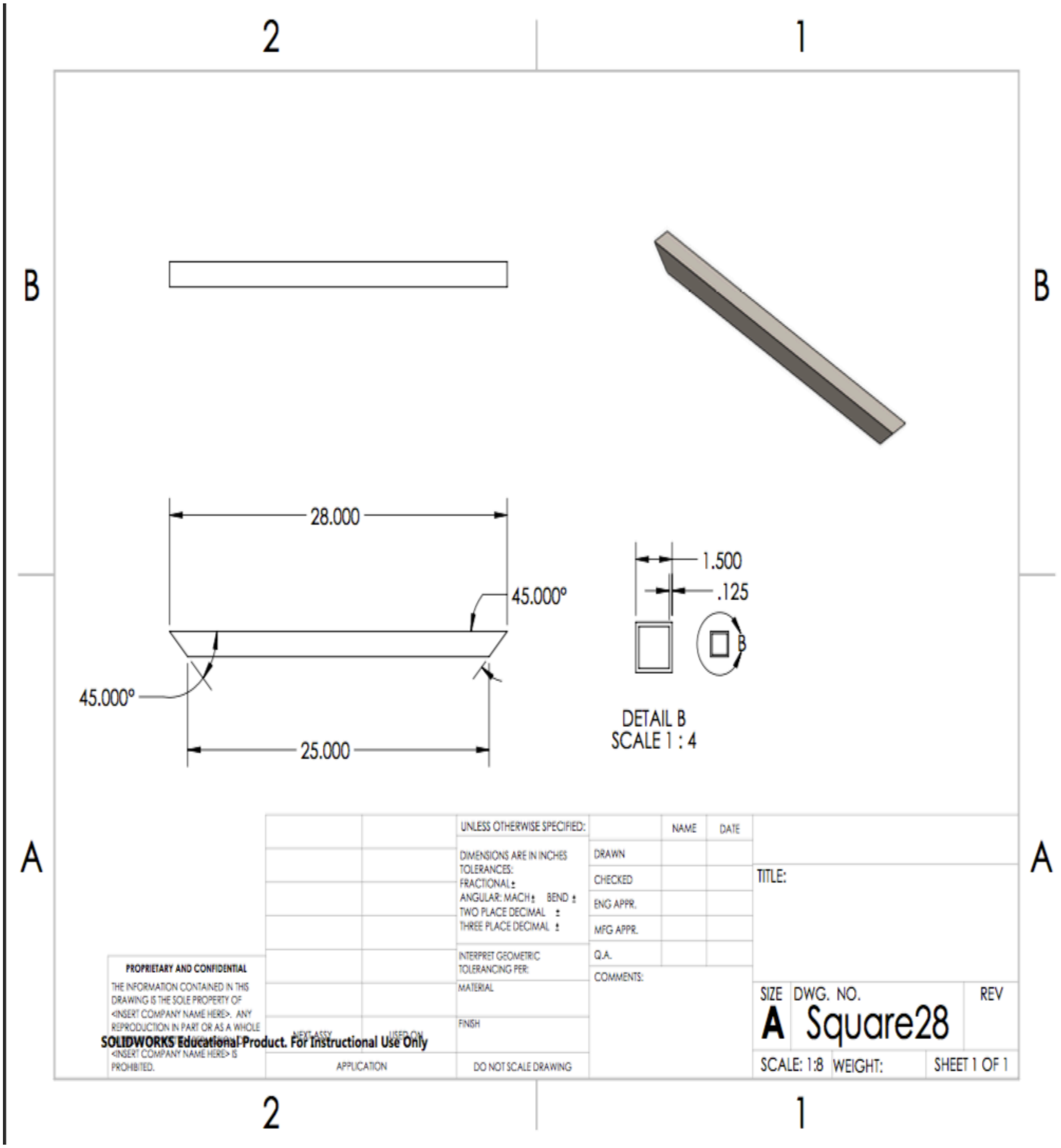
Figure B-16


2
1
B
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28.000
45.000°
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25.000
DETAIL B
SCALE 1 : 4
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TOLERANCES:
FRACTIONAL ±
ANGULAR: MACH ± BEND ±
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COMMENTS:
TITLE:
INTERPRET GEOMETRIC TOLERANCING PER:
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NEXT ASSY
USED ON
SOLIDWORKS Educational Product. For Instructional Use Only
APPLICATION
DO NOT SCALE DRAWING
SIZE
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REV
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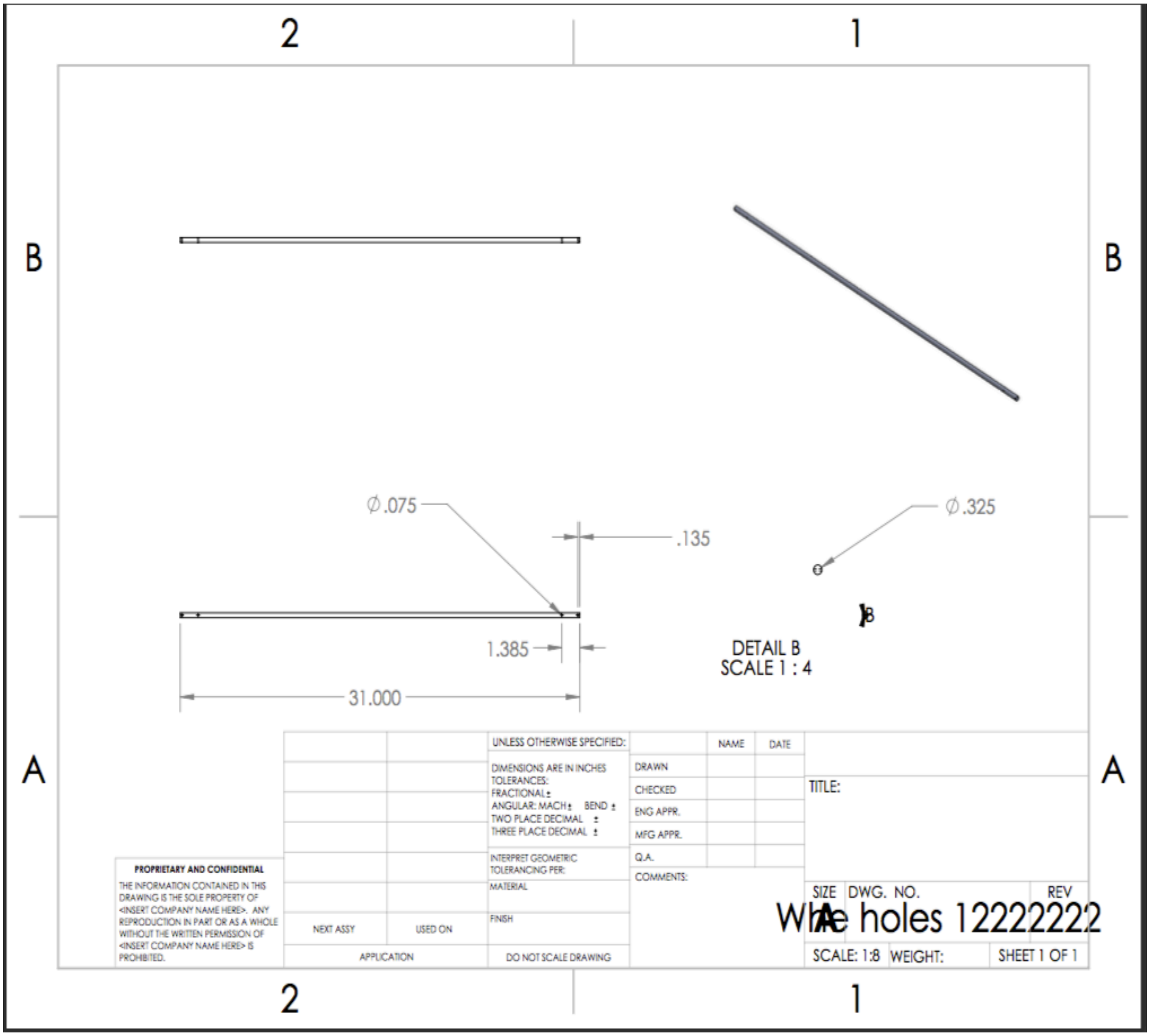
Square28
SCALE: 1:8
WEIGHT:
SHEET 1 OF 1
2
1

Figure B-17



2
1
B
B
Ø.075
.135
Ø.325
B
DETAIL B
SCALE 1 : 4
1.385
31.000
A
A
UNLESS OTHERWISE SPECIFIED:
NAME
DATE
DIMENSIONS ARE IN INCHES
TOLERANCES:
FRACTIONAL±
ANGULAR: MACH± BEND ±
TWO PLACE DECIMAL ±
THREE PLACE DECIMAL ±
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CHECKED
ENG APPR.
MFG APPR.
Q.A.
COMMENTS:
TITLE:
INTERPRET GEOMETRIC
TOLERANCING PER:
MATERIAL
FINISH
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NEXT ASSY
USED ON
APPLICATION
DO NOT SCALE DRAWING
SIZE DWG. NO.
REV
A
Wire holes 12222222
SCALE: 1:8 WEIGHT:
SHEET 1 OF 1
2
1

Figure B-18

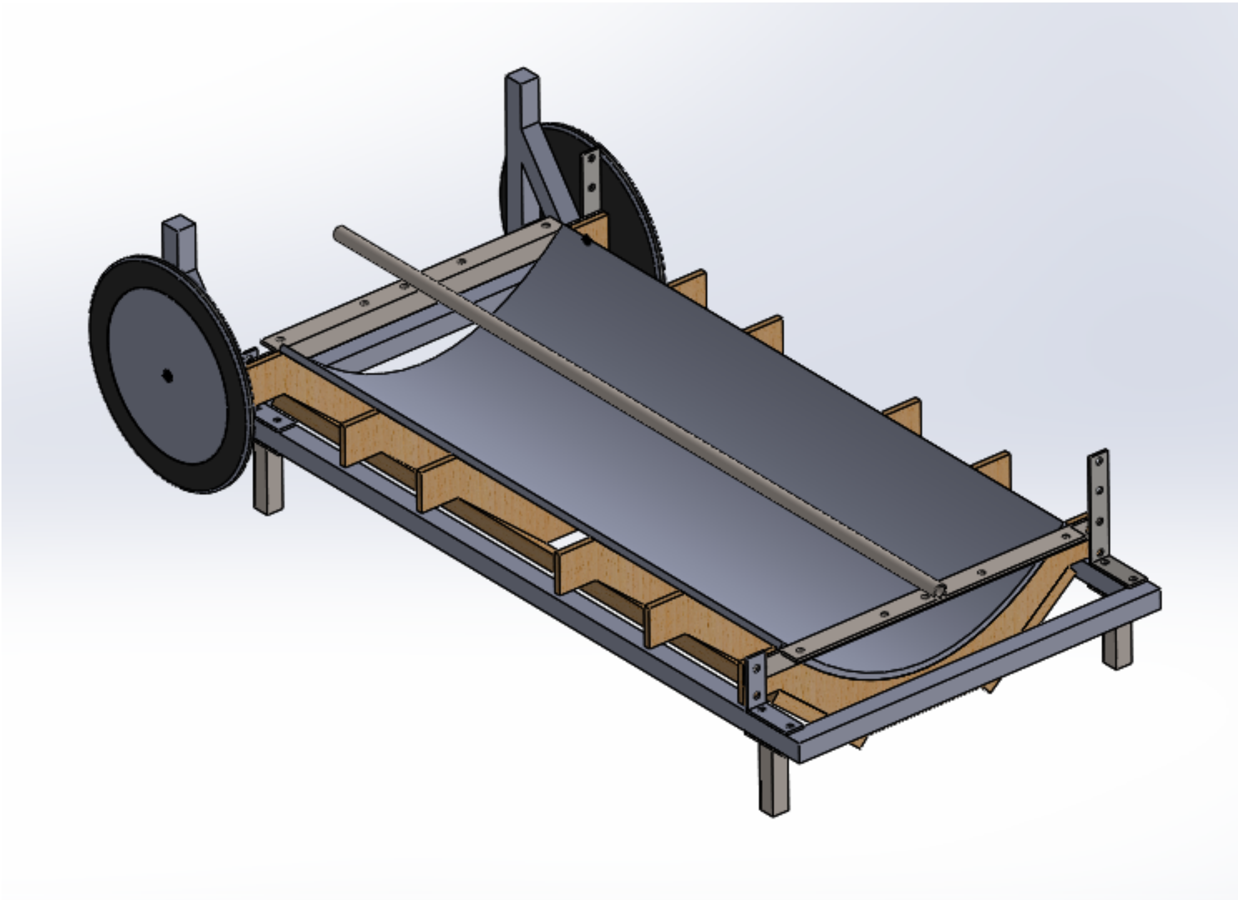


Figure B-19

APPENDIX – (C) List and Costs/Budget

Part	Quantity	Source	Estimated Cost	Actual Cost	Total Cost
WELDED STAINLESS TUBE 304/304L	1 pcs (60”) Wall 0.049	www.onlinemetals.com	52 $	35$	35 $
ALUMINUM BARE SHEET	1 pcs (50X28.5)	www.onlinemetals.com	70 $	35$	38$
Domestic aluminium square pipe (1.5 ”)	2 pcs (90”)	http://www.onlinemetals.com	35 $	37$	74$
Reflective acrylic sheet (2mm)	1pcs (50 in x 28.5 in)	amazon.com	10 $	19.47$	19.47$
Nuts and bolts and washers (6 mm dia d 2.5”)	32 pcs	www.amazon.com	0.50 $/ pcs	0.50 $/ pcs	16 $
1 inch screws (3 mm dia)	10 pcs	www.amazon.com	0.39 $/ pcs	0.39 $/ pcs	3.90$
Wood board 1”	2 pcs (50in x 9.5)		0 $	0 $	0 $
Wheels (10” dia)	1 pcs (10”)	amazon.com	14.99 $	14.99 $	14.99
Wire Round Lock Pin	2 pcs	Home depot	10.88$	10.88 $	21.74$
1" Tube OD x 3/4" MNPT SS Fitting Swagelok	2 pcs	ebay.com	10 $ per pcs	18.75$	37.5$
Total			257.77$		260.62$

Figure C-1

APPENDIX (D) – Schedule

Ali Alismail

Task	ACTIVITY	PLAN START Week	PLAN DURATION (Weeks)	ACTUAL START Week	ACTUAL DURATION (Weeks)	PLAN DURATION (Hours)	ACTUAL DURATION (Hours)
1	Proposal Introduction	1	1	1	2	1	1
2	Functions and Requirements	2	1	2	2	1	1
3	Introduction	3	1	2	3	2	4
4	Design and Analysis	4	1	4	2	4	6
5	Methods/Construction/Part Drawings	5	1	5	1	2	5
7	Testing Method	6	1	6	1	3	4
8	Budget and Schedule	7	1	7	1	1	4
9	Discussion	8	1	8	1	1	2
10	Conclusion	9	1	9	1	2	2
11	Finalize Appendices/Acknowledgements/References	10	1	10	1	1	3
12	Presentaion with Professors Pringle and Johnson	12	1	12	1	1	1
13	Finalize Proposal	12	1	12	2	2	4
14	Purchase materials for the project	13	1	13	1	3	1
15	Size and Cut the Aluminum Round square Tube for Frame	14	3	14	1	2	1
16	Size and Cut For reflector surface, Aluminum. sheet	14	2	14	1	1	2
17	Size and Cut Reflective acrylic sheet	14	2	14	1	1	1
18	Plan manufacturing methods with Professor Beardsley	14	2	14	1	1	0.3
19	Plan manufacturing methods with Mr. Burvee	14	1	14	1	1	0.3
20	MEMO 1	14	1	14	1	1	1
21	Cut and Size Wood board and using wood shop for CNC	15	1	15	1	2	3
22	MEMO 2	15	1	15	1	1	1
23	Assemble backing, and all part for frame sides - glue and nail together	16	1	16	2	2	3
24	MEMO 3	16	1	16	1	1	0.3
25	Cut and Size for Collector Tubing (STAINLESS TUBE)	17	1	17	1	2	
26	Cuting 45 degree Aluminum Round square Tube for Frame	17	1	17	1	3	2.5
28	MEMO 4	17	1	17	1	1	1
29	Update Proposal	17	1	17	1	2	2
30	Size Wheel	18	1	18	1	1	1
32	Welding the Aluminum Round square Tube for Frame	18	1	18	1	2	2
34	MEMO 5	18	1	18	1	1	1
35	Cut and size manifold backing	19	1	19	1	2	2.5
36	MEMO 6	19	1	19	1	1	1
37	Making holes in the frame	20	1	20	1	2	2
38	Update calculations and proposal	20	1	20	1	2	1
39	MEMO 7	20	1	20	1	1	1
40	Cut and bend aluminum sidings to size	21	1	21	1	0.25	0.3
41	Paint all part of wood to black and the frame	21	1	21	1	1	1
42	Solder/attach fittings to the inlet and outlet collector pipes	21	1	21	1	1	1
43	MEMO 8	21	1	21	1	1	1
44	Connect piping path , pump, valve, flow meter, collector	22	1	22	1	1	1
45	Functional Collector	22	1	22	1	1	1

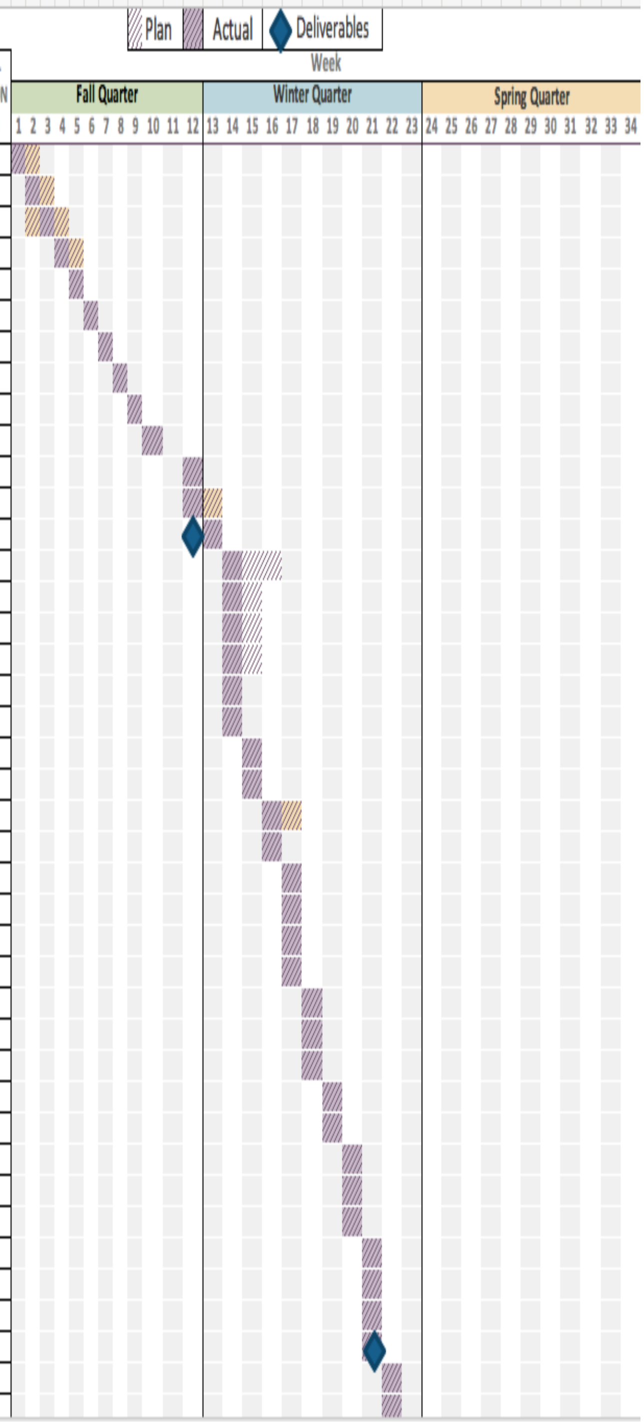


Figure D-1

45	Functional Collector	22	1	22	1	1	1
46	MEMO 9	22	1	22	1	1	0.3
47	Update Website	23	1	23	1	1	1
53	Update Proposal	23	1	23	1	2	2
54	Abstract	24	1	24	1	1	1
55	Update Website	24	1	24	1	1	1
56	Write Short Report	24	1	24	1	1	1
57	Test Plan	25	1	25	1	2	2.3
58	Test 1 April 5 th 2018 12-2pm	25	1	25	1	2	1
60	MEMO About Teasting 2	25	1	25	1	1	0.3
61	Career Accounts	26	1	25	1	1	1
62	Test Demo 1	26	1	25	1	1	0.3
63	MEMO About Teasting 3	26	1	26	1	1	0.3
64	Test 2 April 20th 2018 12-2pm	27	1	27	1	2	2
65	MEMO About Teasting 4	27	2	27	1	1	0.3
66	Test 3 April 24th 2018 12-2pm	28	1	28	1	2	1.5
67	Test 4 April 27th 2018 1-3pm	28	1	28	1	2	2
68	Test Demo 2	28	1	28	1	2	1
69	MEMO About Teasting 5	28	1	28	1	1	0.3
70	Test 5 May 1st 2018 1-3pm	29	1	29	1	2	2
71	Test Report	29	1	29	1	2	1.3
72	Write Short Report About Teasting 6	29	1	29	1	1	0.3
73	SOURCE Poster	30	1	29	1	2	2
74	Write Short Report About Teasting 7	30	1	30	1	1	0.3
75	SOURCE	31	1	31	1	3	3
76	Write Short Report About Teasting 8	31	1	31	1	1	0.3
78	Final Presentations	32	1	32	1	2	2
80	Write Short Report About Teasting 9	32	1	32	1	1	0.3
81	Final Report	33	1	33	1	1	2
82	Write Short Report About Teasting 10	33	33	33	1	1	0.3
				Total Time:		104.25	101.7

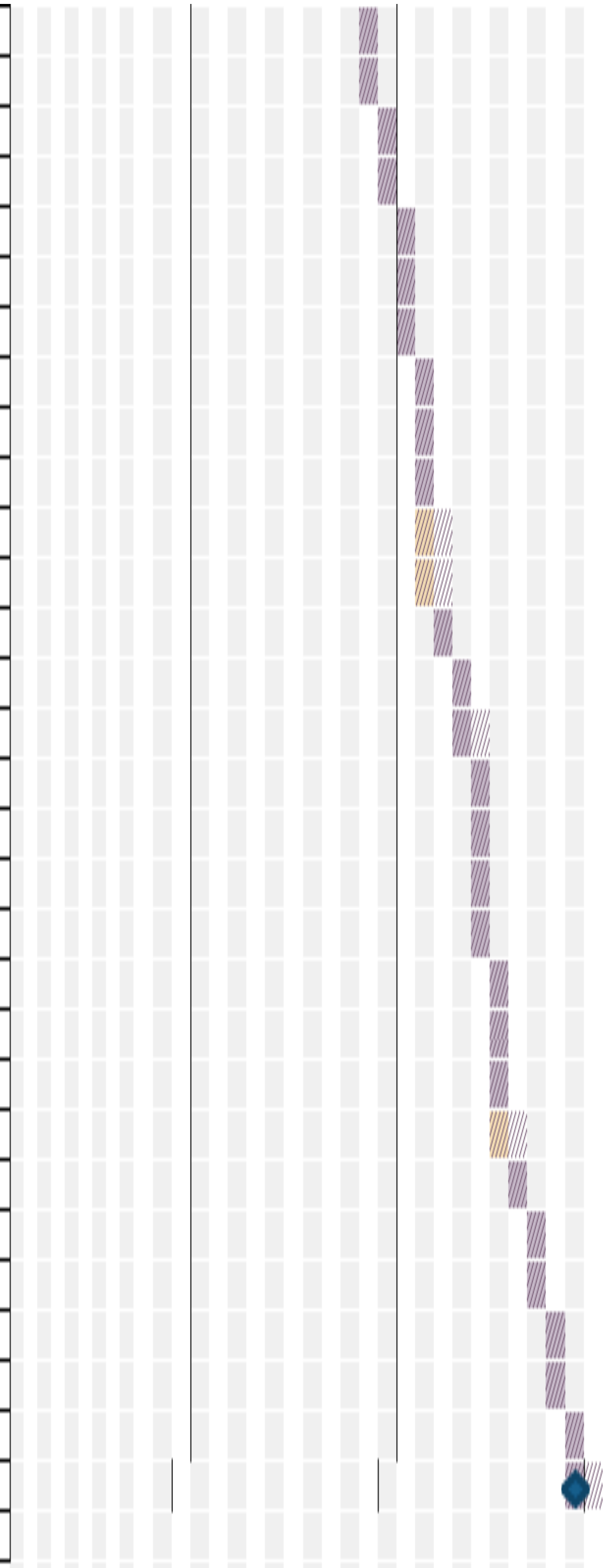


Figure D-2

APPENDIX (E) – Testing Data

Task	Requirement	Actual	Success
1- Transport device	Simple	Simple	Yes
2- Weight	No more than 100 lbs.	90 lbs.	Yes
3- Force to hold up	25 lbs.	20 lbs.	Yes

Figure E-1 shows the result of test Transport and weight of the device.

Trial	Time (Minutes)	Solar irradiance (W/m^2)	Inlet temperatures (ºC)	Outlet temperatures (ºC)	Q_{in} (W)	Q_{out} (W)
1	30	923	23	95	686	104.4
2	28	932	23.5	95	577	111
3	28	932	23.5	95	577	111
4	32	920	23	95	570	97

Figure E-2 shows the result of test the performance of the solar collector.

Q_{in}	Q_{out}	Efficiency
686	104.4	0.152186589
577	111	0.19237435
577	111	0.19237435
570	97	0.170175439

Figure E-3 shows Efficiency VS Solar Energy Density

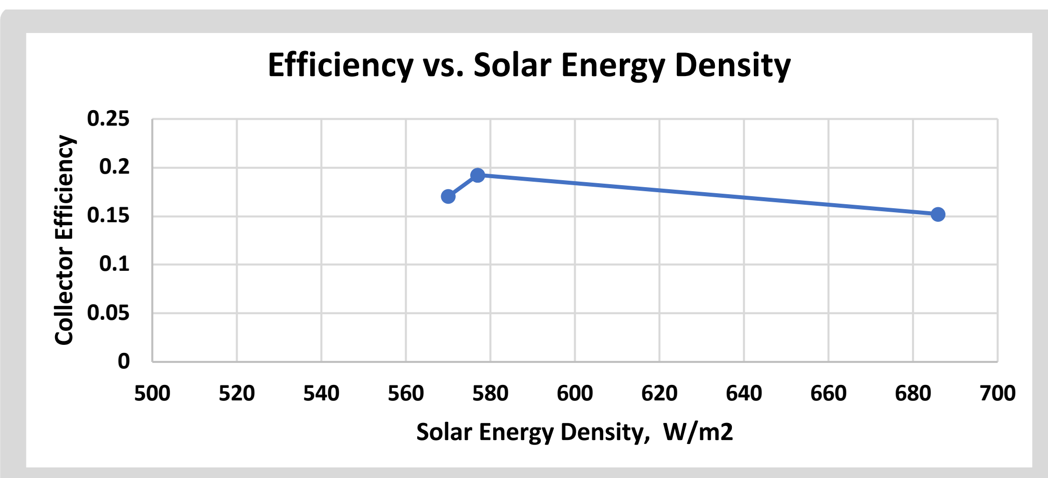
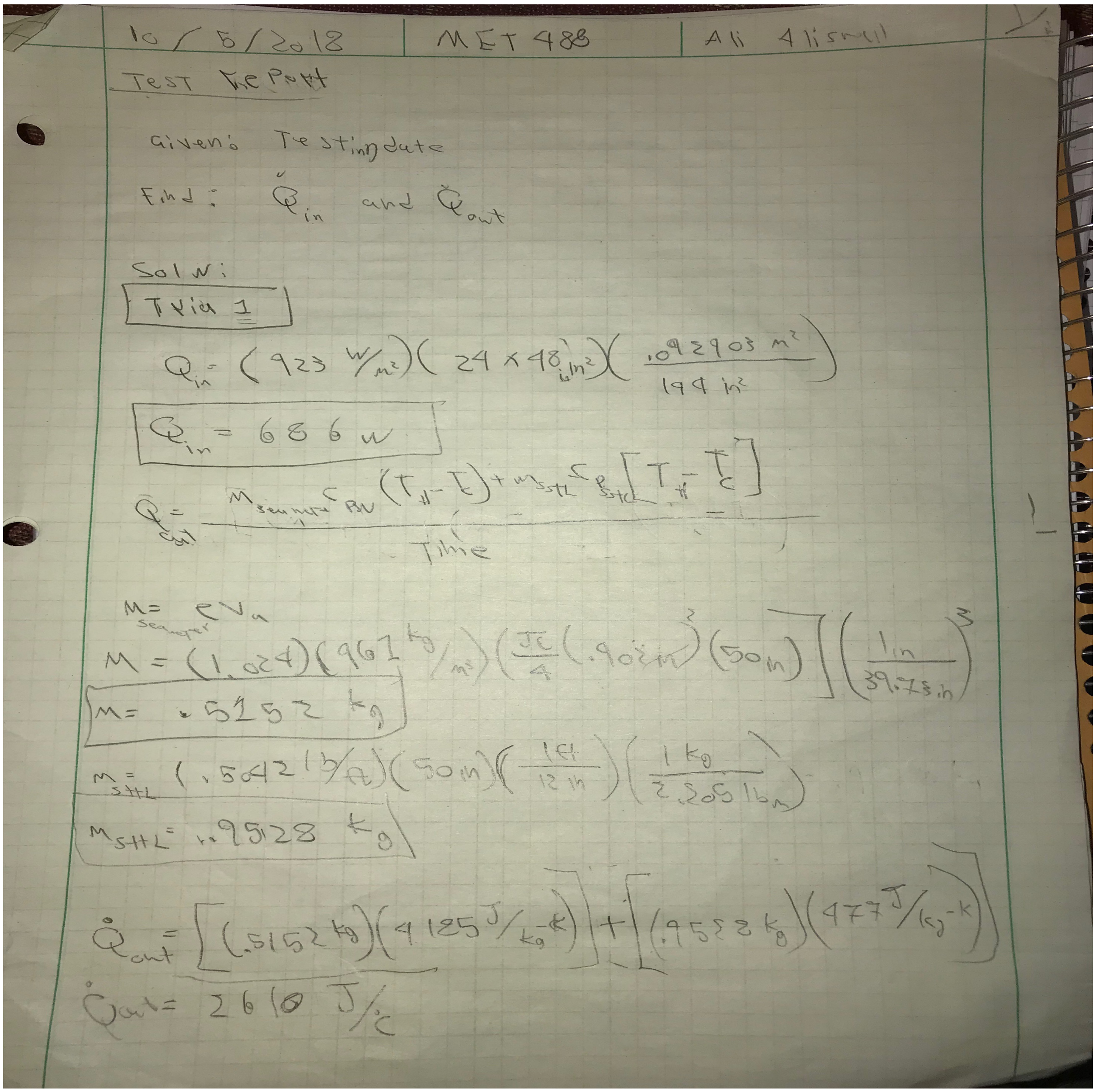


Figure E-4 shows Efficiency VS Solar Energy Density

APPENDIX (F) – Data Evaluation Sheets



10/5/2018 | MET 488 | Ali Alismail

Test Report

Given: Testing data

Find: $\dot{Q}_{in}$ and $\dot{Q}_{out}$

Soln:

Trial 1

$Q_{in} = (923\ W/m^2)(24 \times 48\ in^2)\left(\frac{.092903\ m^2}{144\ in^2}\right)$

$Q_{in} = 686\ W$

$\dot{Q}_{out} = \frac{m_{seawater} c_{pw}(T_H - T_c) + m_{stl} c_{p,stl}[T_H - T_c]}{Time}$

$M_{seawater} = \rho V_a$

$M = (1.024)(961\ kg/m^3)\left(\frac{\pi}{4}(.908\ in)^2(50\ in)\right]\left(\frac{1\ in}{39.78\ in}\right)^3$

$M = .5152\ kg$

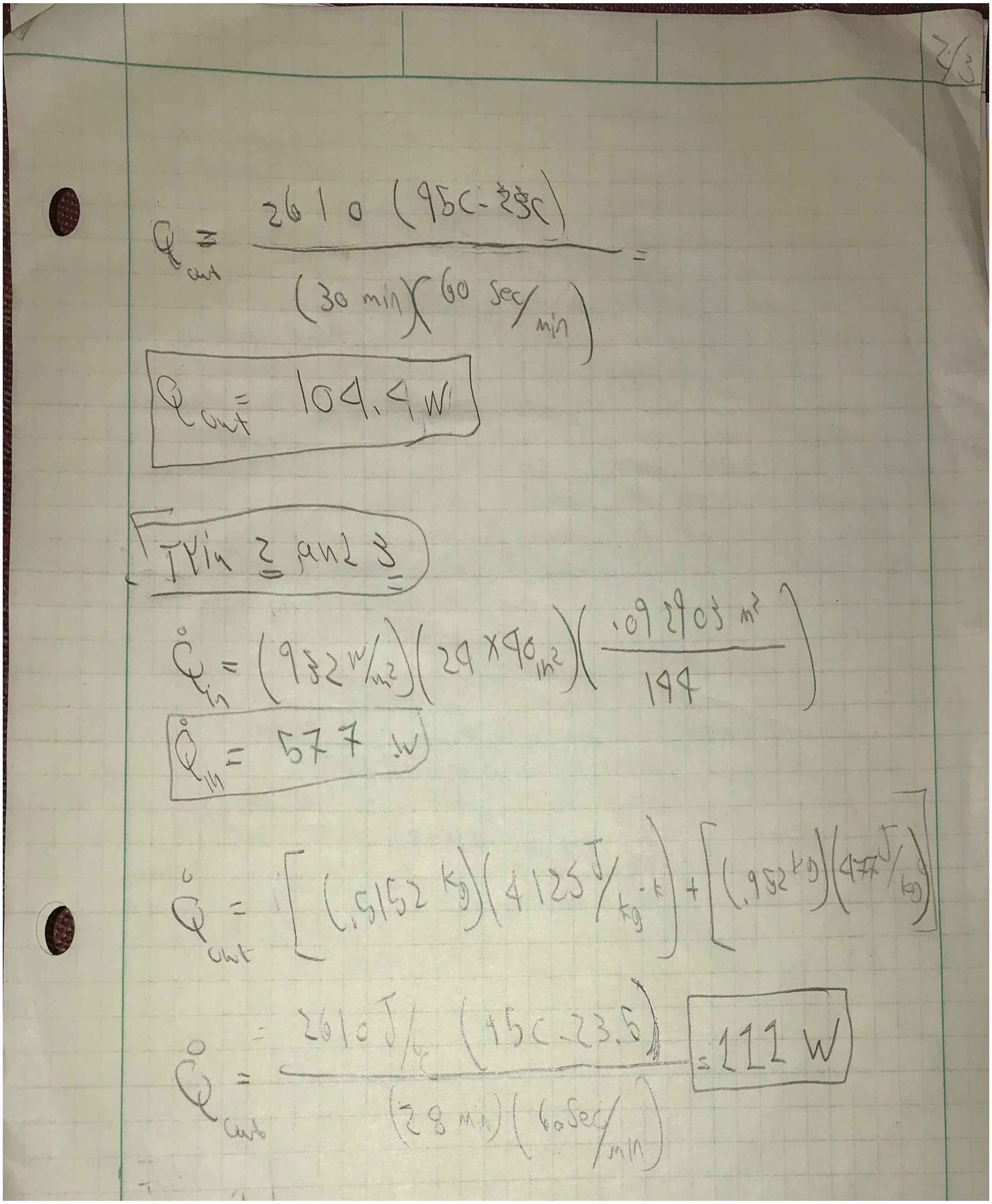
$m_{stl} = (.5042\ lb/ft)(50\ in)\left(\frac{1\ ft}{12\ in}\right)\left(\frac{1\ kg}{2.205\ lb_m}\right)$

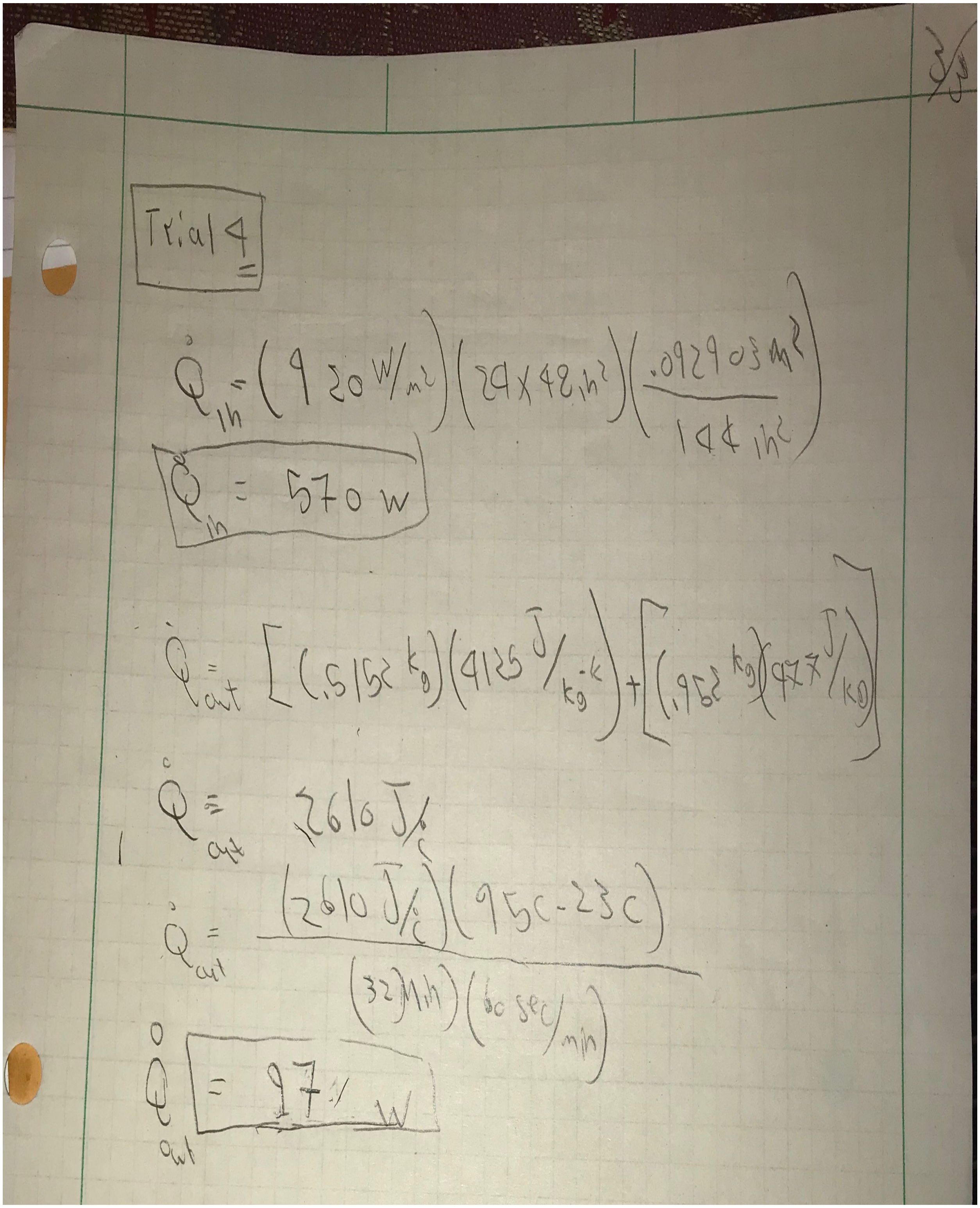
$m_{stl} = .9528\ kg$

$\dot{Q}_{out} = [(.5152\ kg)(4125\ J/kg\text{-}K)] + [(.9528\ kg)(477\ J/kg\text{-}K)]$

$\dot{Q}_{out} = 2616\ J/C$

Figure E-5


2/3
Q out = 2610 (95C-23C) / (30 min)(60 sec/min) =
Q out = 104.4 W
Trial 2 and 3
Q in = (932 W/m²)(29 x 90 in²)(.092903 m² / 144)
Q in = 577 W
Q out = [(.5152 kg)(4125 J/kg·K)] + [(.952 kg)(477 J/kg)]
Q out = 2610 J/K (95C-23.5) / (28 min)(60 Sec/min) = 111 W
Figure E-6



Trial 4

$\dot{Q}_{in} = (920\ W/m^2)(29 \times 48\ in^2)\left(\frac{.092903\ m^2}{144\ in^2}\right)$

$\dot{Q}_{in} = 570\ W$

$\dot{Q}_{out} = \left[(.5152\ kg)(4125\ J/kg\text{-}K)\right] + \left[(.962\ kg)(477\ J/kg)\right]$

$\dot{Q}_{out} = 2610\ J/C$

$\dot{Q}_{out} = \frac{(2610\ J/C)(95C - 23C)}{(32\ min)(60\ sec/min)}$

$\dot{Q}_{out} = 97.1\ W$

Figure E-7

APPENDIX (G) – Testing Report

Introduction:

The purpose of testing method for this project was to provide access to clean drinking water when clean water supplies are not available but nondrinkable water and solar energy is available. Testing on Outdoor Weather ability. The finished device must be:

- Prototype collector to be no more than 24 x 50 inches for going through doorways etc.
- Be able to absorb and utilize at least 70% of the incoming solar radiation on a day where irradiance is equal to 800 W/m2.
- The result in the efficiency and heating capacity of the collector to be 95^{o}C.
- Cost no more than $500 to manufacture.
- The device must be transportable simply for a long distance and it is required no more than 25 lbs. of force to hold up when the device is transport.
- Weight no more than 100 lbs.
- Take no more than 30 hours to manufacture.

Method/Approach:

First part of test was the device must be transportable simply from inside Hogue building to outside the building and it is required no more than 30 lbs. of force to hold up when the device is transport.

The project was using solar power to distill seawater into drinking water. A concentrating solar collector was used to focus the solar energy onto a collector tube to produce hot seawater at 95C. Several methods are expected to be used to test the performance of the solar collector. The first method was involving measurement of the incoming solar irradiance using weather condition data outside Hogue Technology building Secondly, the temperature difference between the input and outlet water was measured. An efficient solar collector should have a temperature difference of about 95 degrees Celsius. For better results, the performance testing methods should be done at an interval of 20 minutes for a period of 2 hours. Other data that can be collected during the testing process include the solar collector dimensions, Cp, and water density. These data were helping in calculating the heat transfer coefficient, Qdot.

Test Procedures:

The testing for the device was on two test parts:

Test 1: Transport and weight of the device.
Time: 10 minutes.
Place: Outdoor
The following steps for testing 1:

7. Making sure a concentrating solar collector is locked by locking pin that concentrating solar collector is not moving.

8. Transport the device easily by rolling on attached wheels from inside building to outside the building (similar to a hand truck).
9. Set down the device vertically slowly.
10. Remove locking from a concentrating solar collector and set up a concentrating solar collector 30°
11. The entire device should place in direct sunlight with collector tube aligned on the east to west polar axis (not magnetic poles).
12. Measure Prototype collector to make sure if it is no more than 24 x 50 inches by using Tape Measure.

Test Documentation and Discussion:

The following figure (E-1 in appendix E) shows the result of test Transport and weight of the device.

Task	Requirement	Actual	Success
4- Transport device	Simple	Simple	Yes
5- Weight	No more than 100 lbs.	90 lbs.	Yes
6- Force to hold up	25 lbs.	20 lbs.	Yes

Figure E-1

Safety:

Safety must be taken when removing the device not damage because the device weighs over 80 lbs. Also, Stepdown the device vertically carefully because the device heavy.

Test 2: The performance of the solar collector
Time: 30 minutes.
Place: Outdoor
The following steps for testing 2:

3. Measure solar irradiance by using weather.com, Licor Li-200SA sensor or another device.
4. Measure inlet and outlet seawater temperatures by using Thermometers.

Test Documentation and Discussion:

The following figure (E-2 in appendix E) shows the result of test the performance of the solar collector.

Trial	**Time** (Minutes)	**Solar irradiance** (W/m^2)	**Inlet temperatures** (°C)	**Outlet temperatures** (°C)	Q_{in} (W)	Q_{out} (W)
1	30	923	23	95	686	104.4
2	28	932	23.5	95	577	111

3	28	932	23.5	95	577	111
4	32	920	23	95	570	97

Figure E-2 shows the result of test the performance of the solar collector.

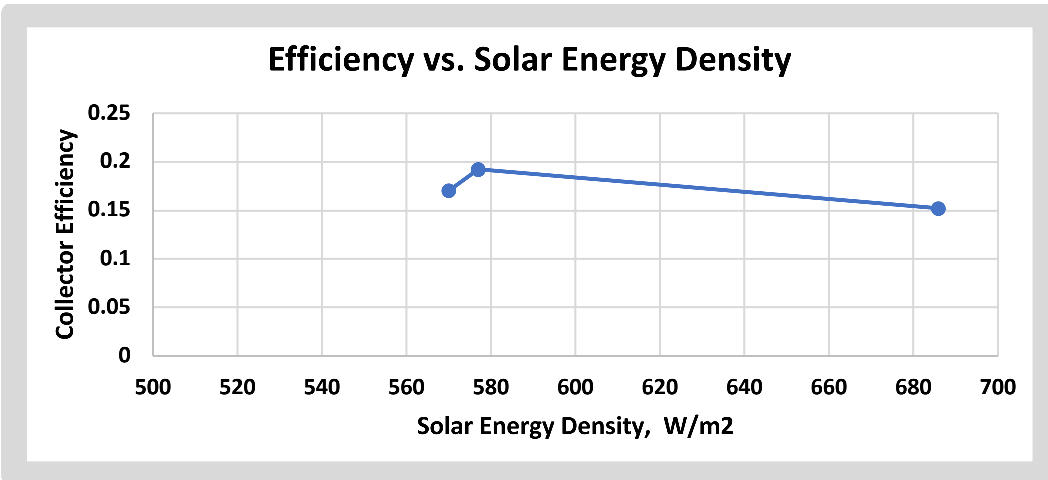


Figure E-4 shows Efficiency VS Solar Energy Density

Safety:

Safety must be taken when testing the performance of the solar collector not to touch the stainless-steel pipe because it is heating in high temperature and this might lead to burn the hands or fingers.

Conclusion

The reason for testing was using skills in Mechanical Engineering Technology major. The main objective of this test was design and fabricate a seawater distiller attached to a parabolic solar collector for heating seawater with improved efficiency and an easy to transport stand on which. Lastly, the test was successful due to the support of all the mentoring because was able to absorb and utilize 70% of the incoming solar radiation on a day where irradiance is equal to 800 W/m2.

APPENDIX (H) – Resume

Ali Alismail,

707 E 18th apt #5 Ellensburg WA 9896, Tel: +15098992017, Email: am22822@hotmail.com

Profile Summary

I am a dynamic, team spirited, and performance driven fresh with an automotive engineering major. I have keen ability to increase efficiency, improve component and process designs, and eliminate re-engineering design problems, with a blend of leadership and entrepreneurship. I have the ability to motivate and communicate colleagues. I am currently looking for a position in your organization where I can bring immediate value and attain overall company goals.

Core Competencies

- Product and process design and improvement
- Ability to work under pressure
- Multi -project manager/coordinator skills and team player.
- Ability to work under minimum supervision.
- Ability to visualize, articulate and solve both simple and complex problems

Educational Background

Central Washington University, BSC in Mechanical Engineering (Second Class Honors-Upper), April 2017.

Work Experience

General Worker in Oil Factory HKSS, Formerly H. K. AL-SADIQ Est, June 2011 – September 2011

Key Responsibilities

i. Installation and servicing of generators and pumps.
ii. Generator module wiring and programing.
iii. Generator and pumps commissioning.
iv. Servicing of agricultural machineries.

Skills

- AutoCAD
- Autodesk Inventor
- MasterCAM
- SolidWorks
- MatLab
- Working Model
- Language Fluency: English and Arabic
- MS office

Major Research Projects

- September 2015 – May 2016: A study of energy conversion. Solar panel design.

Academic Awards

Best applied science exhibit project, Central Washington University, 2016.