Marble Mayhem – Accessible Painting with Plinko

Duncan Bauserman, Catherine Dehaemers, Jared Hutton, Lauren Jones

Johnson County Developmental Supports

KU SCHOOL OF ENGINEERING
The University of Kansas

Problem Statement

Goal → Construct an interactive device that supports individuals' efforts to express themselves through painting.

- The device should be designed so that it is easily accessible for a wide range of different needs, all while improving the user's control over the art they create.
- This device will increase the independence of the people that are using it.

Specifications

- Utilize one switch to operate
- Able to be used by individuals with a wide set of varied needs
- Components should be easily purchasable and/or easy to acquire
- Cost ~$75 to construct
- Lifespan of ~5 years
- Able to withstand wear and tear of daily use
- User Controlled
- Require minimal technical knowledge to construct and operate

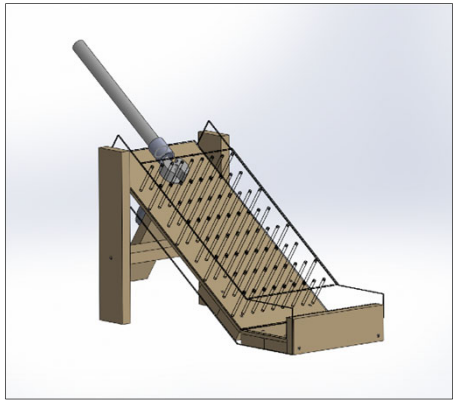
Background

Johnson County Developmental Supports (JCDS) nurtures career and personal development for residents of Johnson County with developmental and intellectual disabilities. The mission of the organization is to "focus on individuals' abilities, provide choice-driven supports, and advocate alongside people to live and work in our community." (1) JCDS serves 500+ individuals every day.

(1) Toft. "About Developmental Supports." Johnson County Kansas, 2022, https://www.jocogov.org/department/developmental-supports/about-developmental-supports.

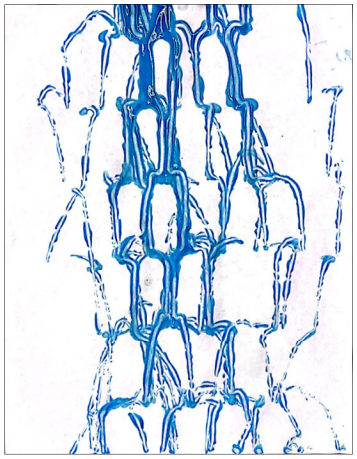
The Design

Assembly:



- **Clear acrylic top, sides, & bottom** → better visuals & easy clean up
- **Wood structure** → inexpensive & structurally sound
- **72 staggered acrylic pins** → increase design variability
- **Top sheet attached to sides with Velcro** → easy access to paper below
- **PVC pipe holds 22 marbles** → increases independent time
- **Turnkey has 2 marble slots (180° apart)** → constant marble movement
- **Gear reduction motor** → 5 RPM operating at 12 Volts DC for safety
- **PowerLink 3 switch box** → increases safety
- **Push button** → user control → can be switched out for any simple switch

How It Works



- Standard 8.5"X11" piece of paper is placed on the board by removing the clear acrylic top sheet attached by Velcro
- Individuals load the PVC pipe with marbles and acrylic paint
- PVC pipe is attached to connector at the top of the board
- Individual presses push button, causing the turnkey to rotate, pick up a marble, and then release the marble
- As the marble rolls down the incline, it interacts with the acrylic dowel rods to randomize movement
- Marbles leave trails of paint on the paper as it rolls down the device

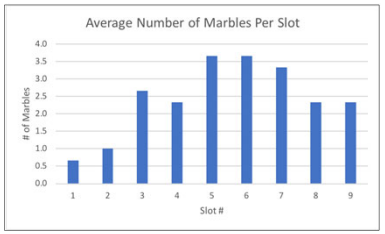
Testing

Run Time: 1 min 59 seconds
→ time it takes for all 22 marbles to be released and reach the bottom with constant power supplied
→ will vary depending on how long the user holds down the push button at a time

Test	Run Time (sec)
#1	115
#2	123
#3	119
Avg.	119

Variability: ↑ paint = ↓ variability
→ number of marbles out of 22 that go through each slot between the pins at the bottom

	Number of Marbles Per Slot								
Slot #	#1	#2	#3	#4	#5	#6	#7	#8	#9
Test 1	1	1	1	1	2	3	5	3	5
Test 2	0	0	3	4	4	5	3	2	1
Test 3	1	2	4	2	5	3	2	2	1
Avg.	0.7	1.0	2.7	2.3	3.7	3.7	3.3	2.3	2.3



Number of Runs Before Cleaning: ~3
→ for optimal performance using non-diluted tempura paint, it is recommended that the device be cleaned after the 3rd run
↓ paint = ↑ runs before cleaning

Marbles Stuck: ↑ paint = ↑ marbles stuck
→ some marbles get stuck on top of the pins due to paint piling up
→ 4/5 (80%) of stuck marbles eventually get knocked down

Test	# Marbles Stuck	Get Knocked?
#1	2	Yes
#2	2	Yes
#3	1	No

Potential Modifications

- **Wooden sides** → Less expensive option
- **Additional Turnkey slots** → Faster marble release
- **Increased number of dowel rods** → More variance
- **Angle Modifications** → Increase or decrease the marble's speed
- **Motor Speed** → Changes the rate of marbles dropped per minute
- **Tubing**→ Larger or smaller tubes change number of marbles per run

ASSEMBLY INSTRUCTIONS

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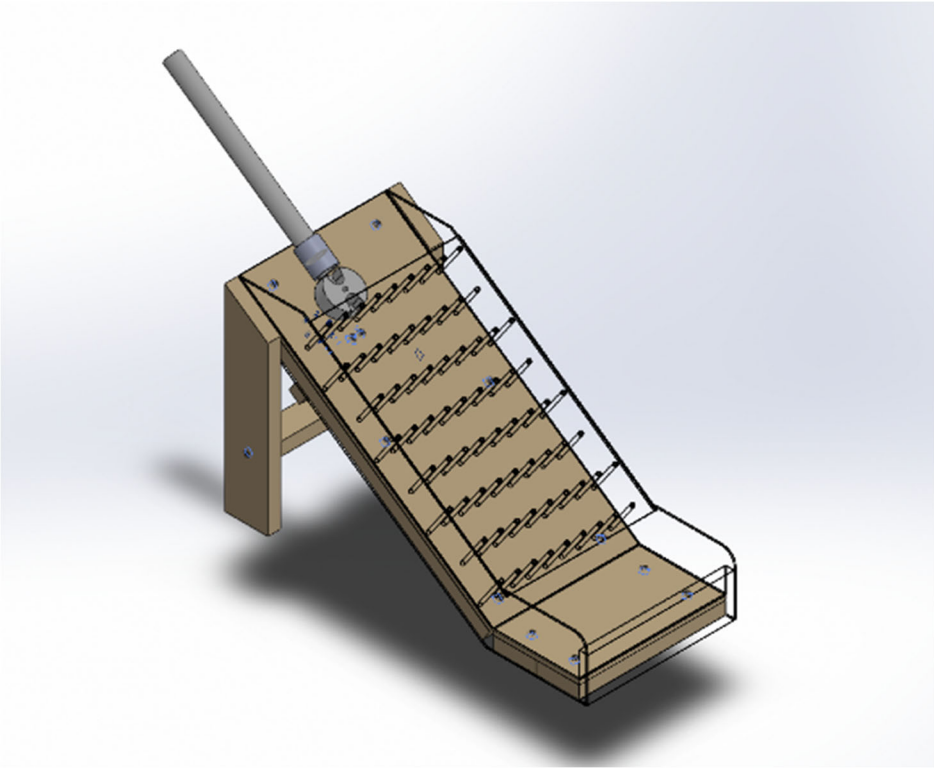

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ME 641

TABLE OF CONTENTS

COMPONENTS

BILL OF MATERIALS

*insert bill of materials

*add where to purchase

*add Velcro and glue

Note: All the materials listed can be purchased at a local hardware store, such as Home Depot, and/or on Amazon.

COMPONENTS

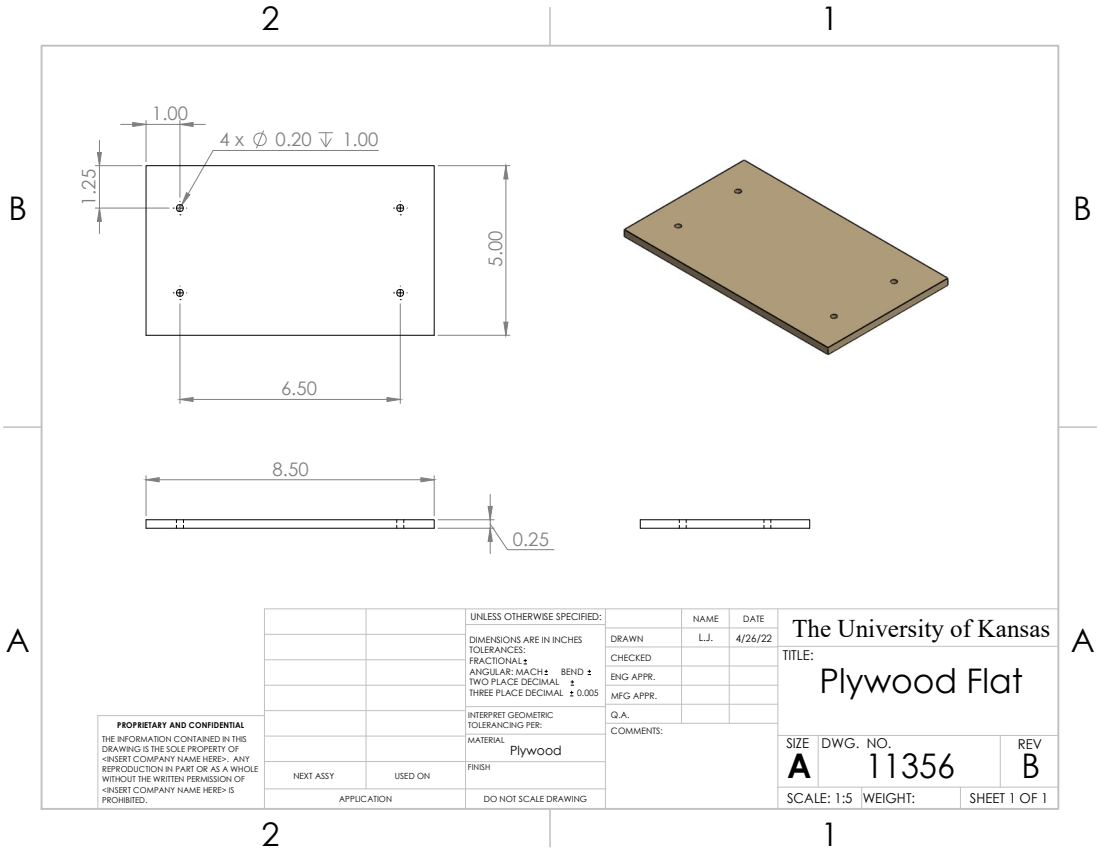
*insert table of parts

- *Note: All assembly instructions are listed under "Assembly Steps"*
    - *13189A – Cover Assembly*

- *11213A – Flat Assembly*
- *11313A – Incline Assembly*
- *11012A – Entire Assembly*

How to Construct Each Part

11356B – Plywood Flat (x1)

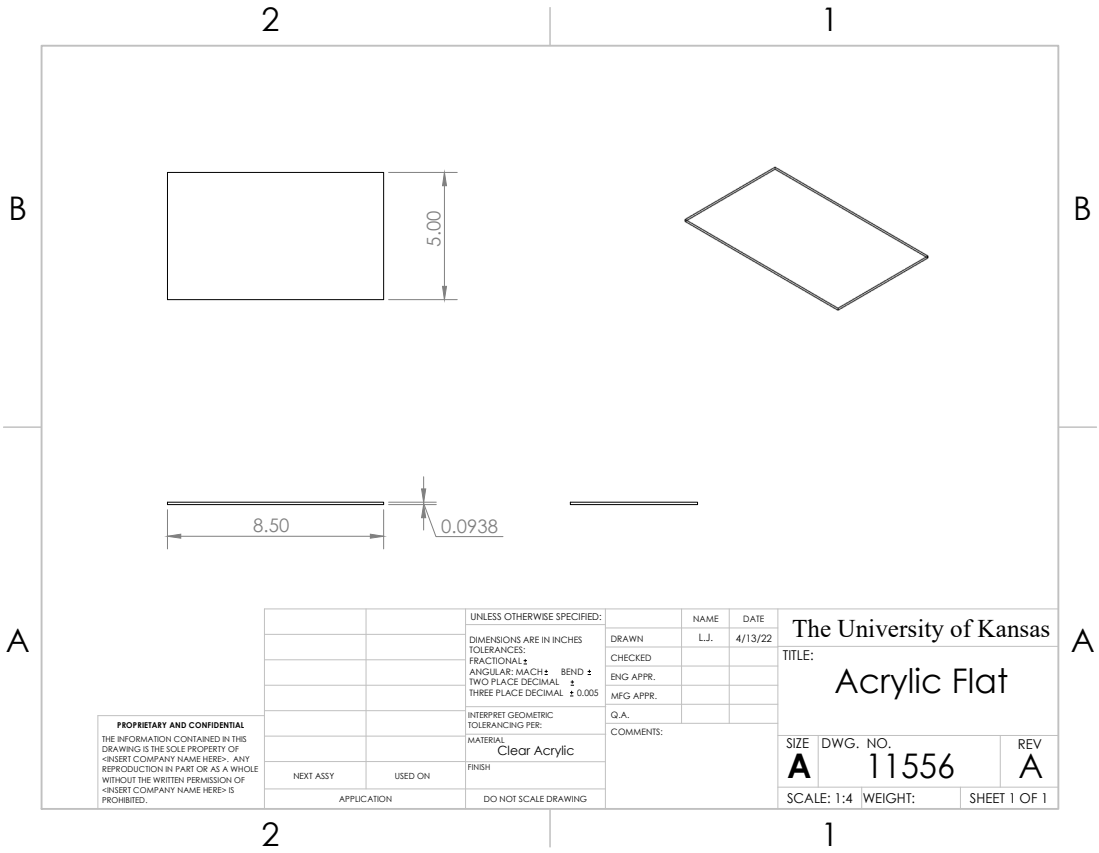


- *Material:*
  - *0.25” thick plywood*
- *Tools required:*
  - *Table or Miter Saw*
  - *Electric Drill*

i. *Cut a 5”x8.5” rectangle out of the 0.25” plywood using a table or miter saw.*

ii. *Drill four 0.2” diameter holes all the way through using an electric drill, in the locations designated on the drawing above.*

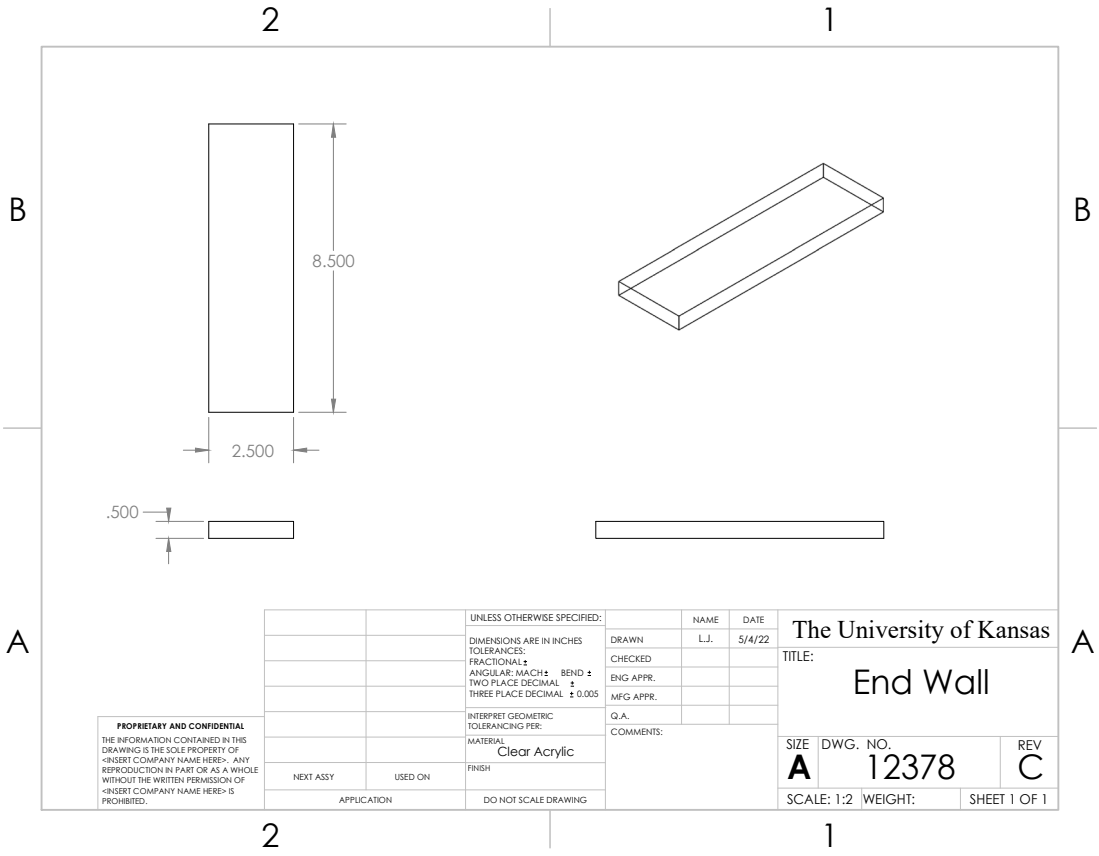
11556A – Acrylic Flat (x1)



- *Material:*
  - *0.0938” thick Crystal Clear OPTIX Acrylic*
- *Tools required:*
  - *Table or Miter Saw*

i. *Cut a 5”x8.5” rectangle out of the 0.0938” thick clear acrylic using a table or miter saw.*

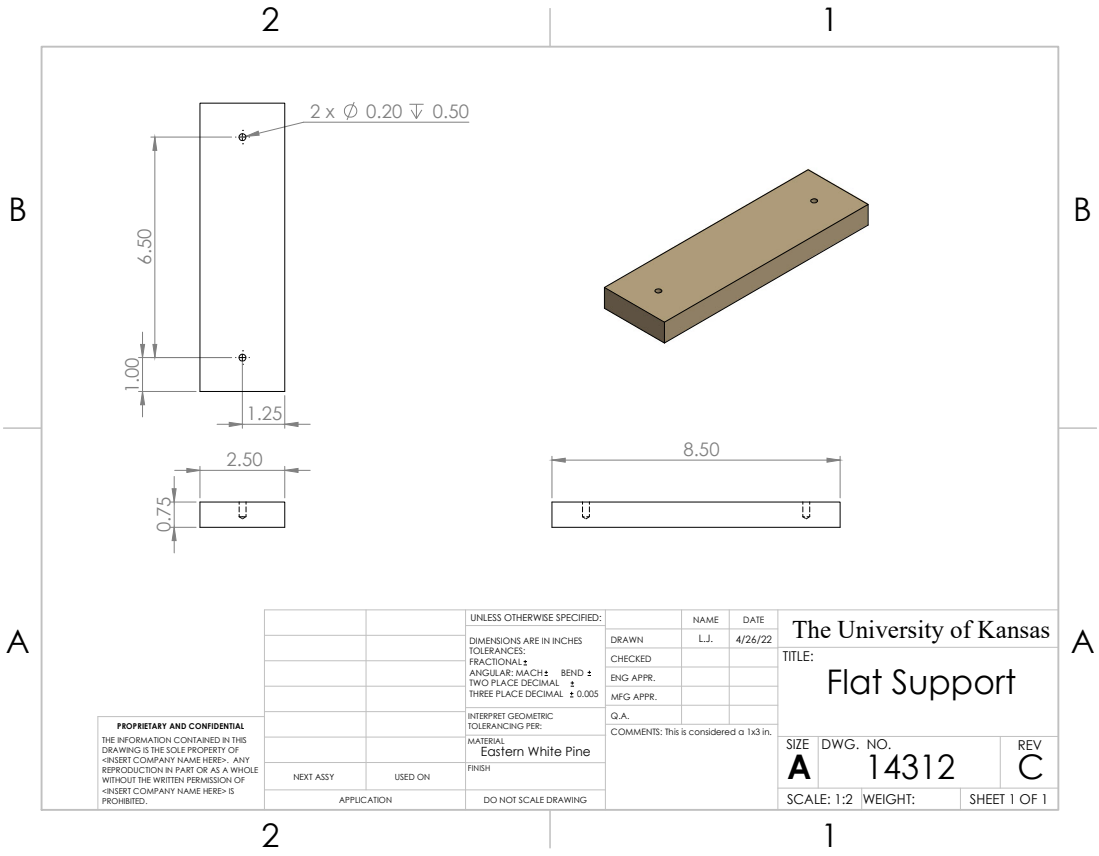
12378C – End Wall (x1)



- *Material:*
  - *0.5” thick Clear Acrylic*
- *Tools required:*
  - *Table or Miter Saw*

i. *Cut a 2.5”x8.5” rectangle out of the 0.5” thick clear acrylic using a table or miter saw.*

14312C – Flat Support (x2)



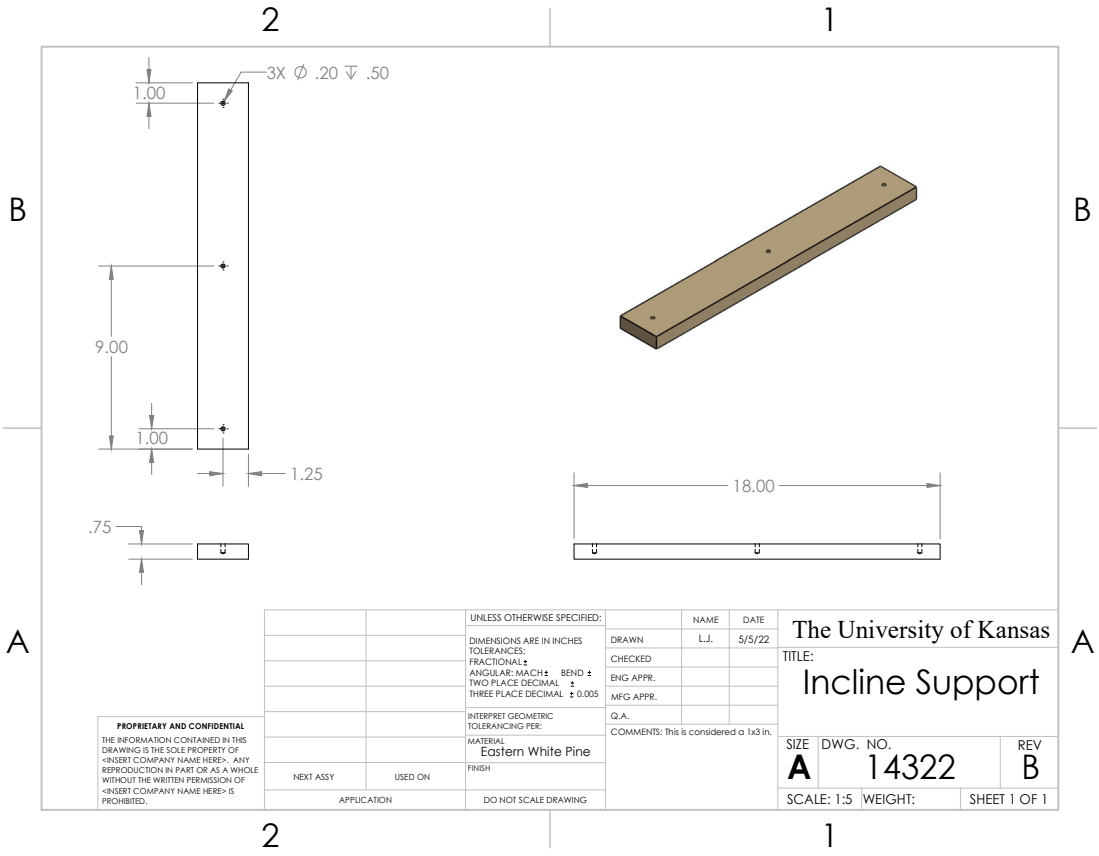
- *Material:*
  - *1”x3” Eastern White Pine Furring Board*
    - *Note: A 1”x3” is only 0.75”x2.5”*
- *Tools required:*
  - *Table or Miter Saw*
  - *Electric Drill*

i. *Cut an 8.5” piece off the 1”x3” Furring Board using a table or miter saw.*

ii. *Drill two 0.2” diameter holes 0.5” deep on the large flat face using an electric drill, in the locations designated on the drawing above.*

iii. *Repeat above steps until four pieces of the component are acquired.*

14322B – Incline Support (x2)



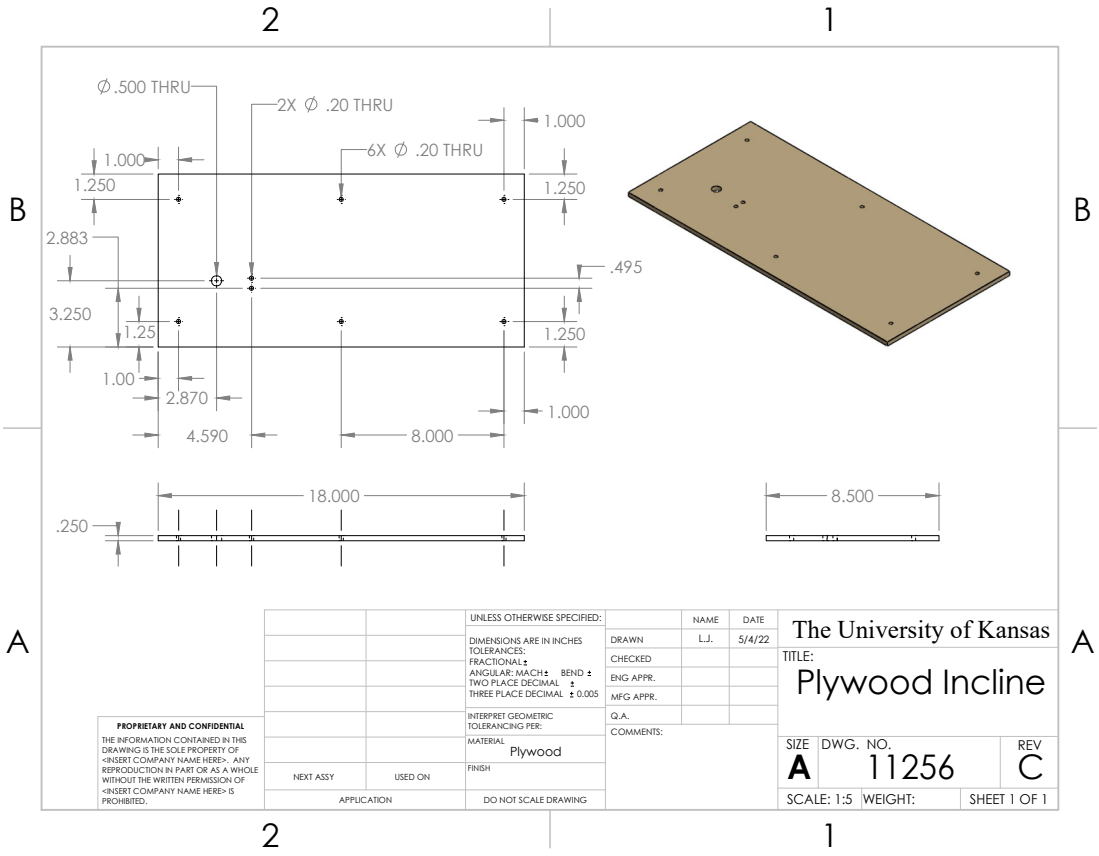
- *Material:*
  - *1”x3” Eastern White Pine Furring Board*
    - *Note: A 1”x3” is only 0.75”x2.5”*
- *Tools required:*
  - *Table or Miter Saw*
  - *Electric Drill*

i. *Cut an 18” piece off the 1”x3” Furring Board using a table or miter saw.*

ii. *Drill three 0.2” diameter holes 0.5” deep on the large flat face using an electric drill, in the locations designated on the drawing above.*

iii. *Repeat above steps until two pieces of the component are acquired.*

11256C – Plywood Incline (x1)



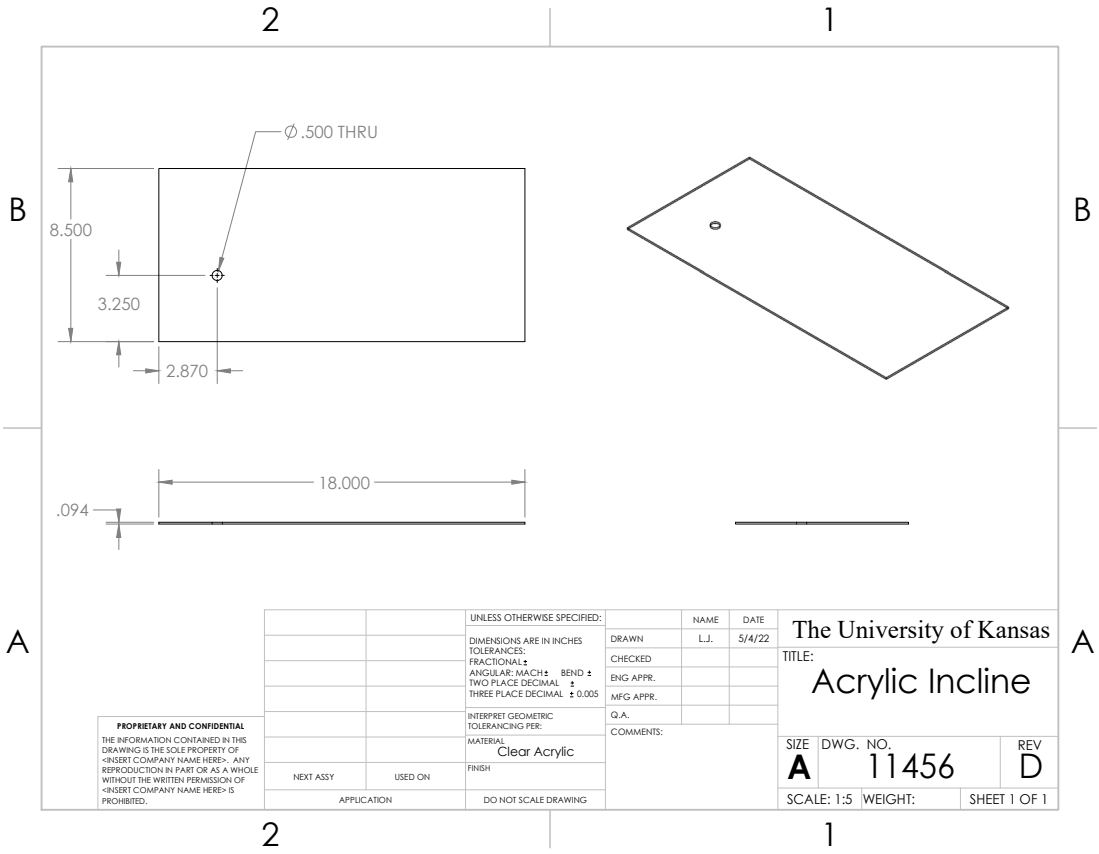
- *Material:*
  - *0.25” thick plywood*
- *Tools required:*
  - *Table or Miter Saw*
  - *Electric Drill*
  - *Hole Saw*

i. *Cut an 18”x8.5” rectangle out of the 0.25” plywood using a table or miter saw.*

ii. *Drill eight 0.2” diameter holes all the way through using an electric drill, in the locations designated on the drawing above.*

iii. *Drill one 0.5” diameter hole all the way through using a hole saw in the location designated on the drawing above (3.25” from side, 2.87” from top).*

11456D – Acrylic Incline (x1)

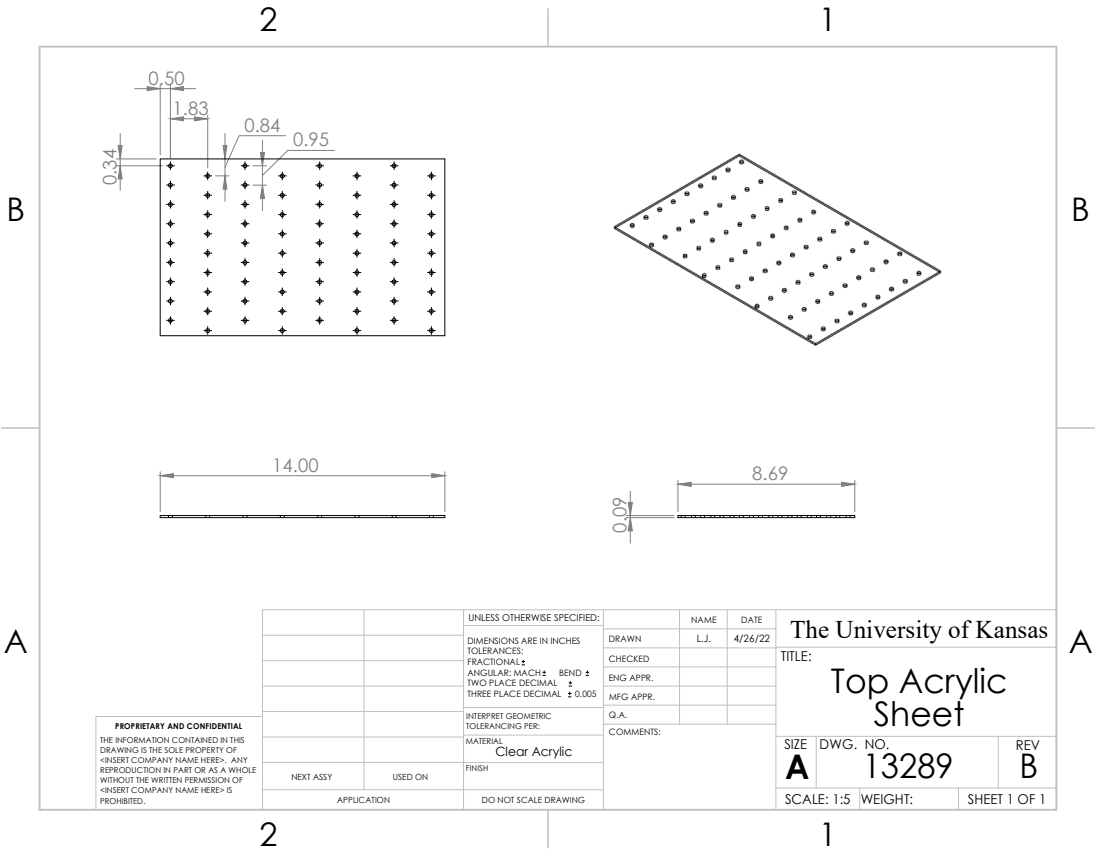


- *Material:*
  - *0.0938” thick Crystal Clear OPTIX Acrylic*
- *Tools required:*
  - *Table or Miter Saw*
  - *Hole Saw*

i. *Cut an 18”x8.5” rectangle out of the 0.0938” thick clear acrylic using a table or miter saw.*

ii. *Drill one 0.5” diameter hole all the way through using a hole saw, in the location designated on the drawing above (3.25” from side, 2.87” from top).*

13289B – Top Acrylic Sheet (x1)



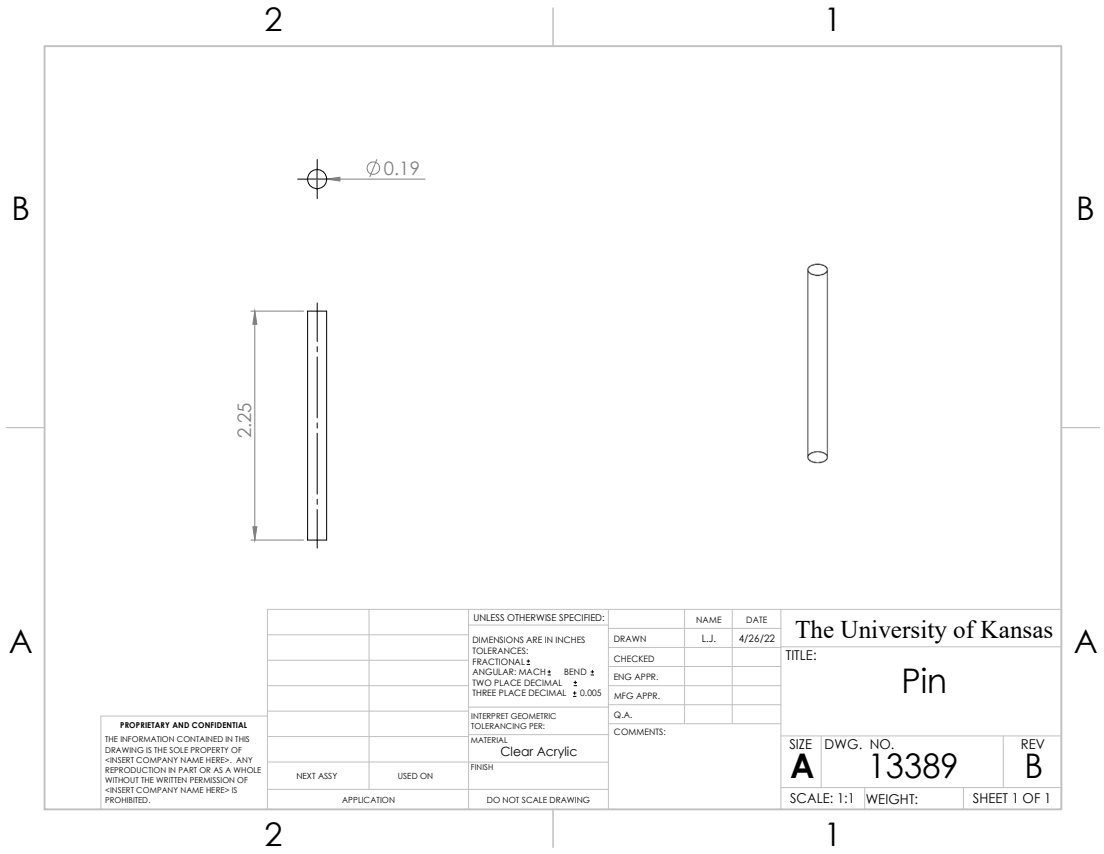
- *Material:*
  - *0.0938” thick Crystal Clear OPTIX Acrylic*
- *Tools required:*
  - *Table or Miter saw*
  - *Laser Cutter, Milling Machine, or Electric Drill*

i. *Cut a 14”x8.69” rectangle out of the clear acrylic using a table or miter saw.*

ii. *Drill seventy-two 3/16” diameter holes all the way through using either a milling machine or electric drill, in the locations designated on the drawing above.*

a. *<u>Optional:</u> Use a laser cutter to cut the holes.*

13389B – Pin (x72)



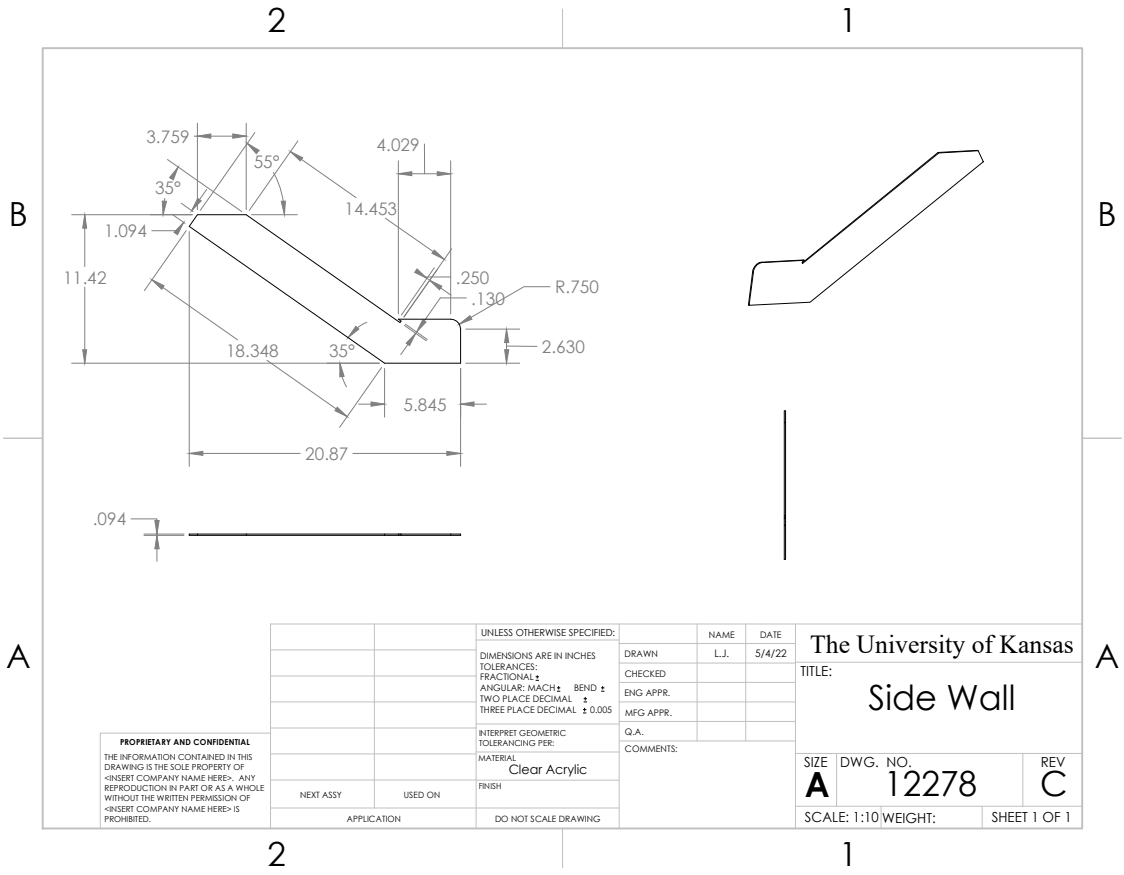
- *Material:*
  - *3/16” diameter Clear Acrylic Rod*
- *Tools required:*
  - *Table or Miter Saw*
  - *Electric Sander*

i. *Cut a 2.25” long pieces out of the clear acrylic rod using a table or miter saw.*

ii. *Remove any rough edges with an electric sander.*

iii. Repeat above steps until seventy-two pieces of the component are acquired.

12278C – Side Wall (x2)



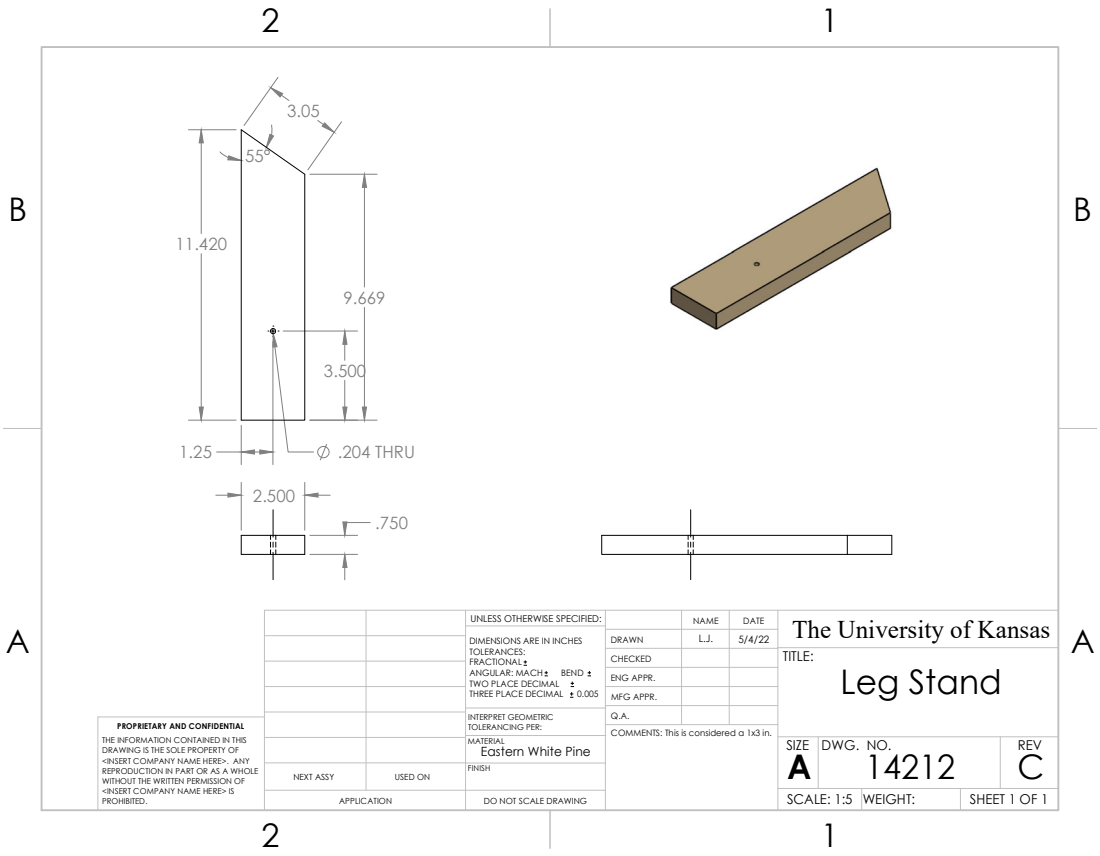
- *Material:*
  - *0.0938" thick Crystal Clear OPTIX Acrylic*
- *Tools required:*
  - *Laser Cutter*
    - *Table or Miter Saw if Laser Cutter is not available*

i. Use a laser cutter to cut out the component from the 0.0938" clear acrylic

a. <u>Optional</u>: Use a table or miter saw to cut out the component.

ii. Repeat above steps until two pieces of the component are acquired.

14212C – Leg Stand (x2)



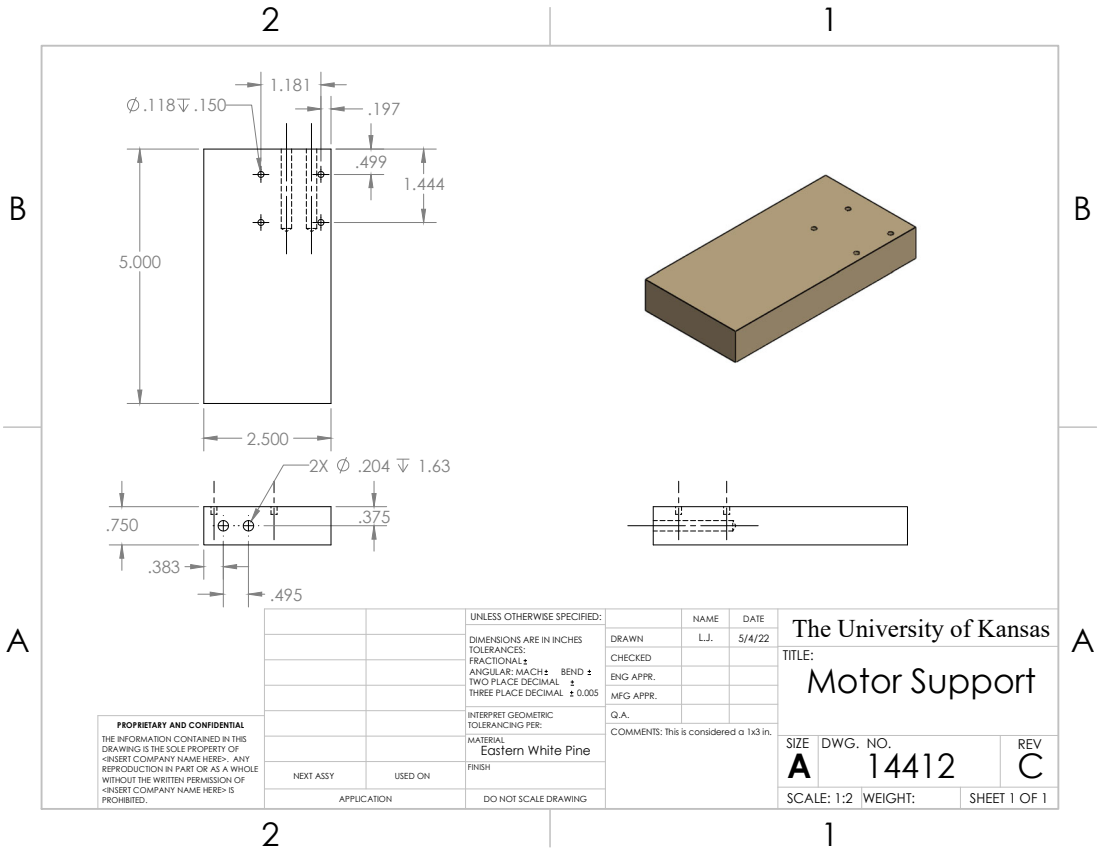
- *Material:*
  - *1”x3” Eastern White Pine Furring Board*
    - *Note: A 1”x3” is only 0.75”x2.5”*
- *Tools required:*
  - *Table or Miter saw*
  - *Electric Drill*

i. Cut a 11.42” piece off the 1”x3” Furring Board using a table or miter saw.

ii. *Drill one 0.204” diameter hole all the way through on the large flat face using an electric drill, in the location designated on the drawing above (1.25” from side, 3.5” from bottom).*

iii. *Repeat above steps until two pieces of the component are acquired.*

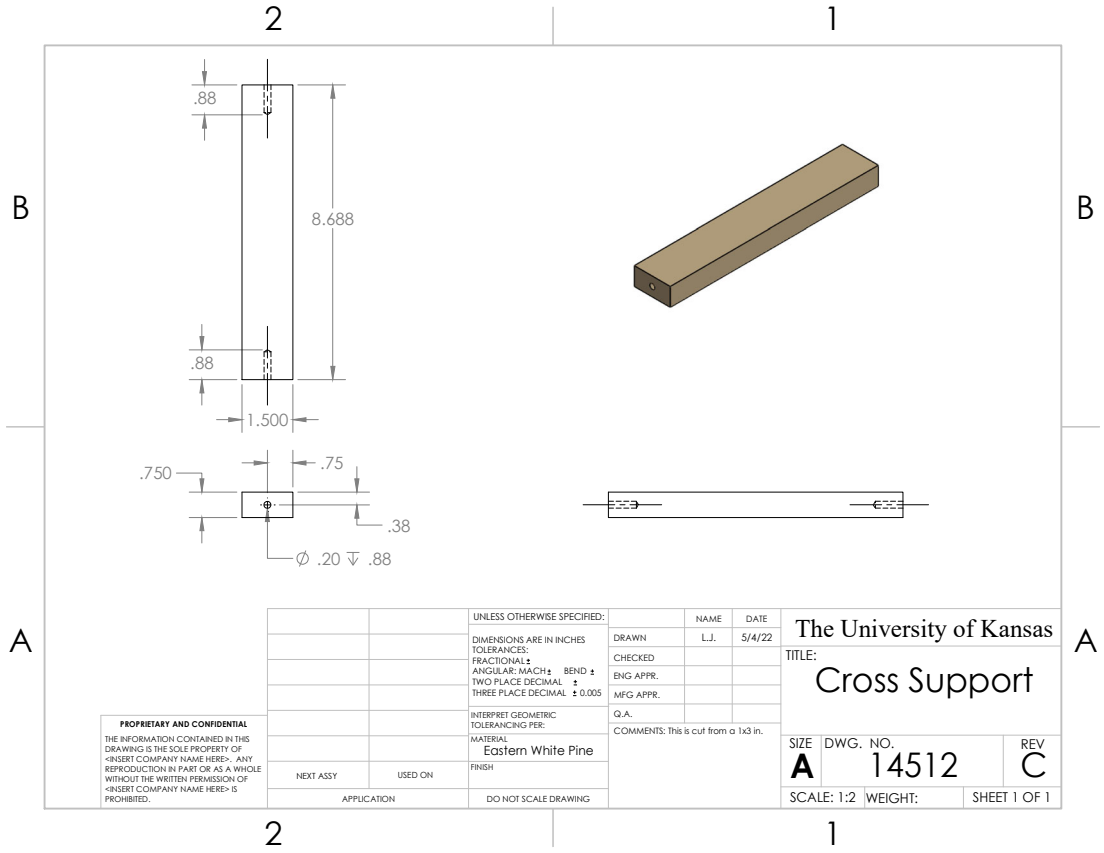
14412C – Motor Support (x1)



- *Material:*
  - *1”x3” Eastern White Pine Furring Board*
    - *Note: A 1”x3” is only 0.75”x2.5”*
- *Tools required:*
  - *Table or Miter saw*
  - *Electric Drill*

i. *Cut a 5” piece off the 1”x3” Furring Board using a table or miter saw.*
ii. *Drill four 0.118” diameter holes 0.15” deep into the large flat face using an electric drill, in the locations designated on the drawing above.*
iii. *Drill two 0.204” diameter holes 1.63” deep into the top face using an electric drill, in the locations designated on the drawing above.*

14512C – Cross Support (x1)



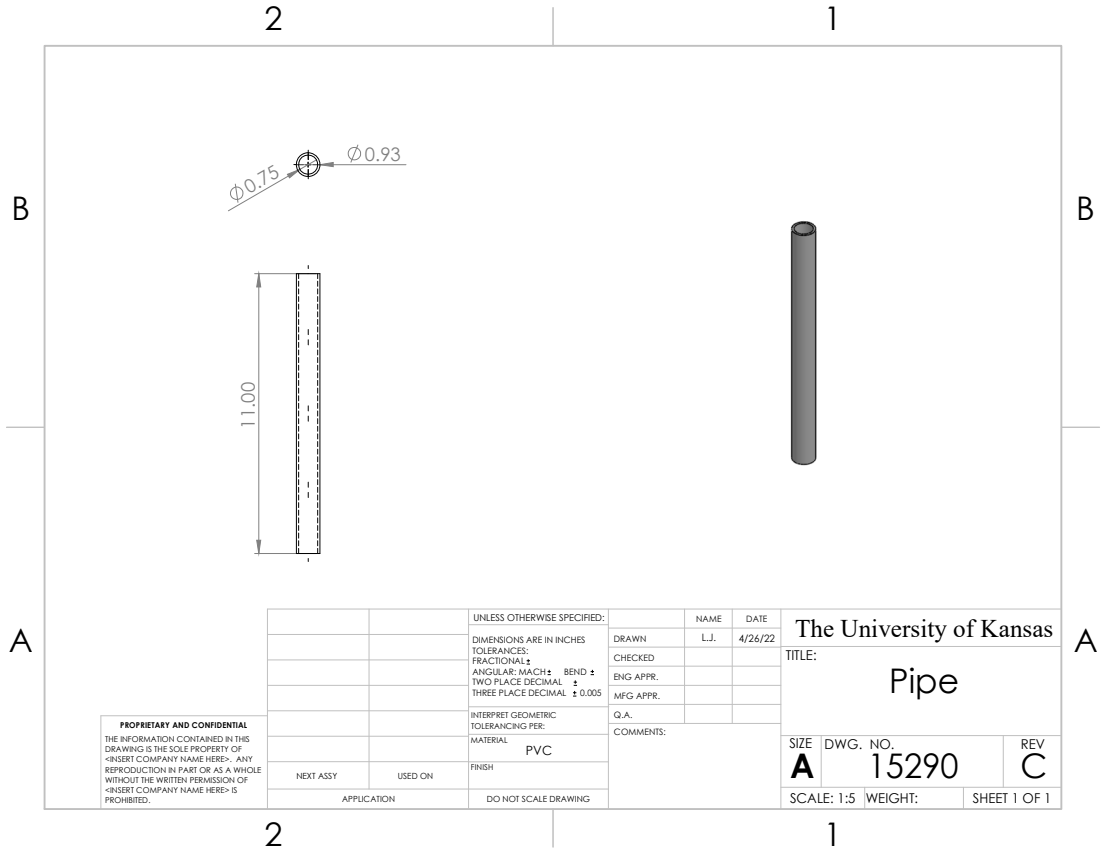
- *Material:*
  - *1”x3” Eastern White Pine Furring Board*
    - *Note: A 1”x3” is only 0.75”x2.5”*
- *Tools required:*
  - *Table or Miter saw*

- *Electric Drill*

i. *Cut a 1.5”x8.688” piece off the 1”x3” Furring Board using a table or miter saw.*

ii. *Drill one 0.2” diameter hole 0.88” deep on each end face using an electric drill, in the locations designated on the drawing above (0.75” from side, 0.38” from top).*

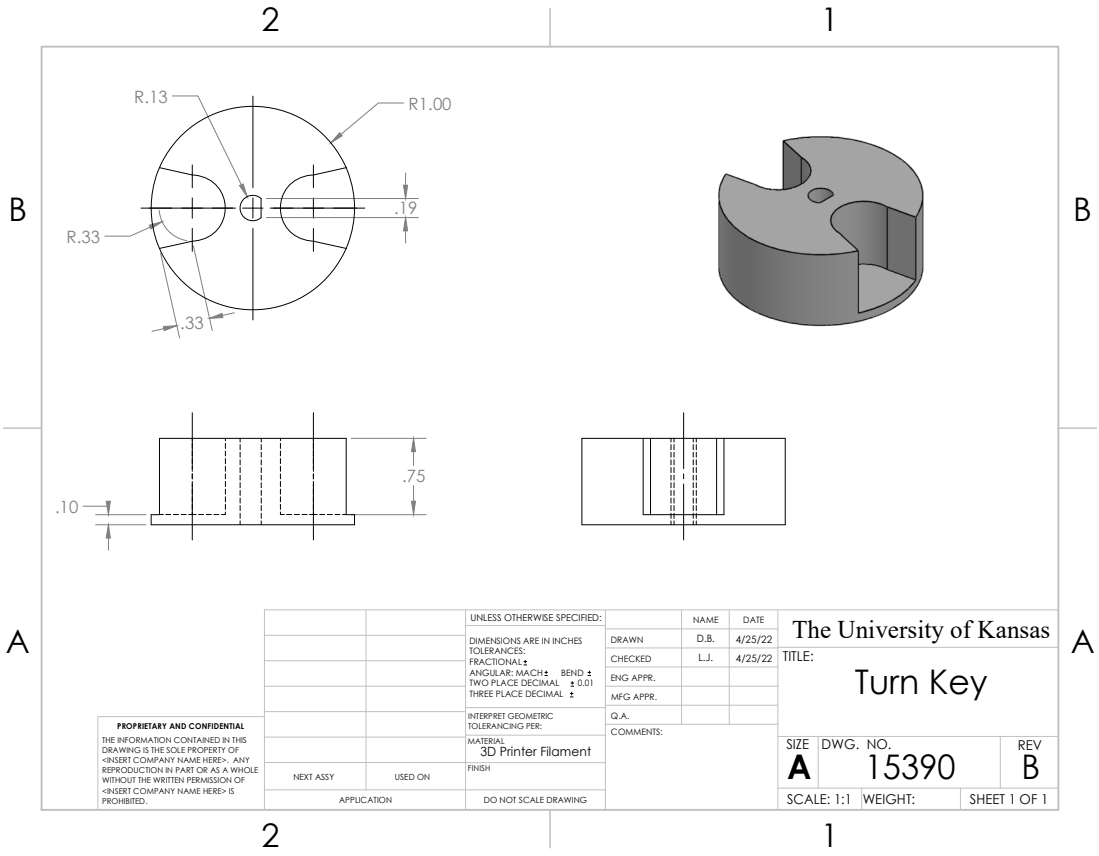
15290C – PVC Pipe (x1)



- *Material:*
  - *¾” PVC Pipe*
- *Tools required:*
  - *Table or Miter saw*

i. *Cut an 11” piece off of the ¾” PVC Pipe*

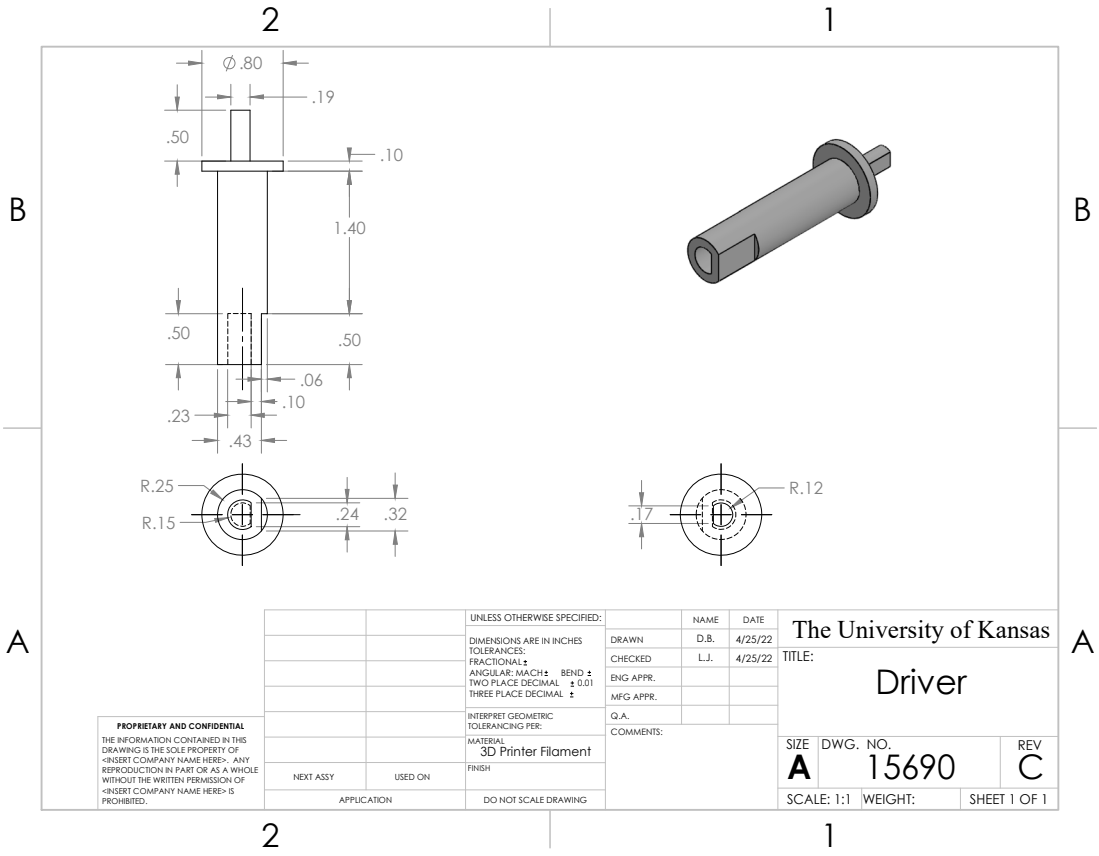
15390B – Turn Key (x1)



- *Material:*
  - *3D Printer Filament*
- *Tools required:*
  - *3D Printer*

i. *Load the .stl file of the Turn Key (15390B) into a 3D printer and allow to print.*

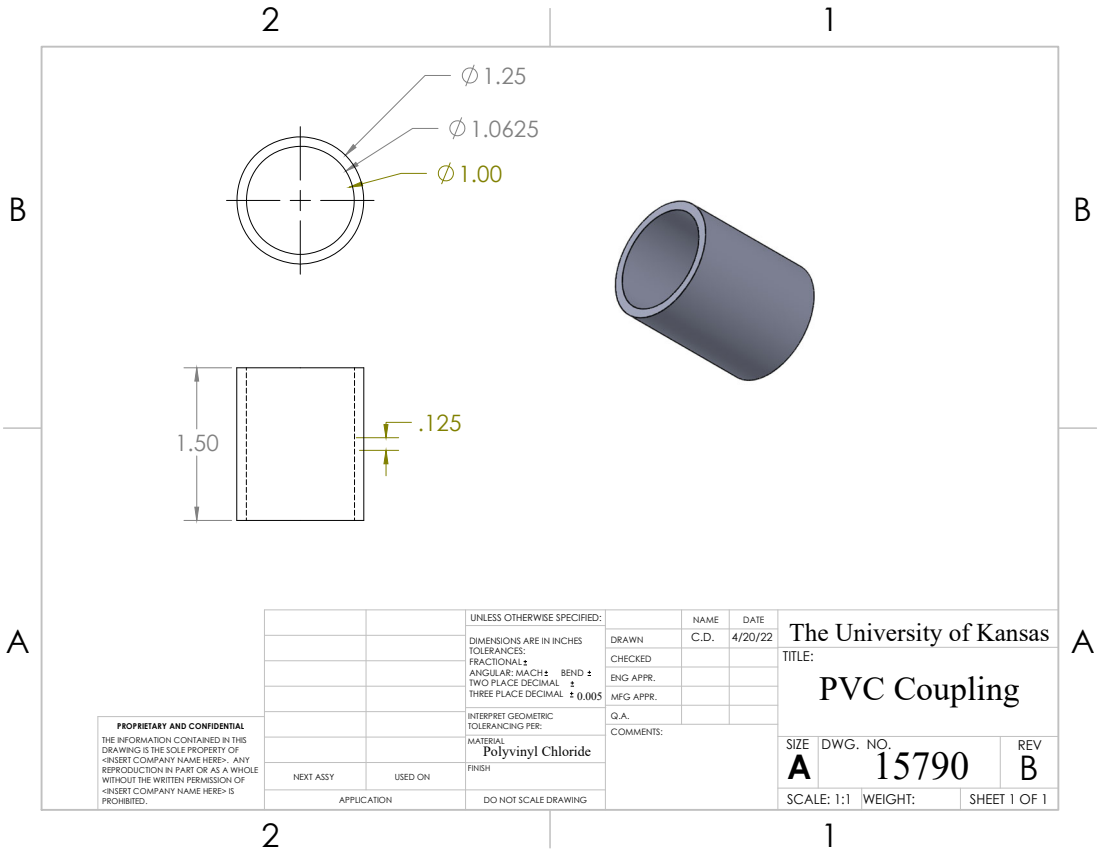
15690C – Driver (x1)



- *Material:*
  - *3D Printer Filament*
- *Tools required:*
  - *3D Printer*

i. *Load the .stl file of the Driver (15690C) into a 3D printer and allow to print.*

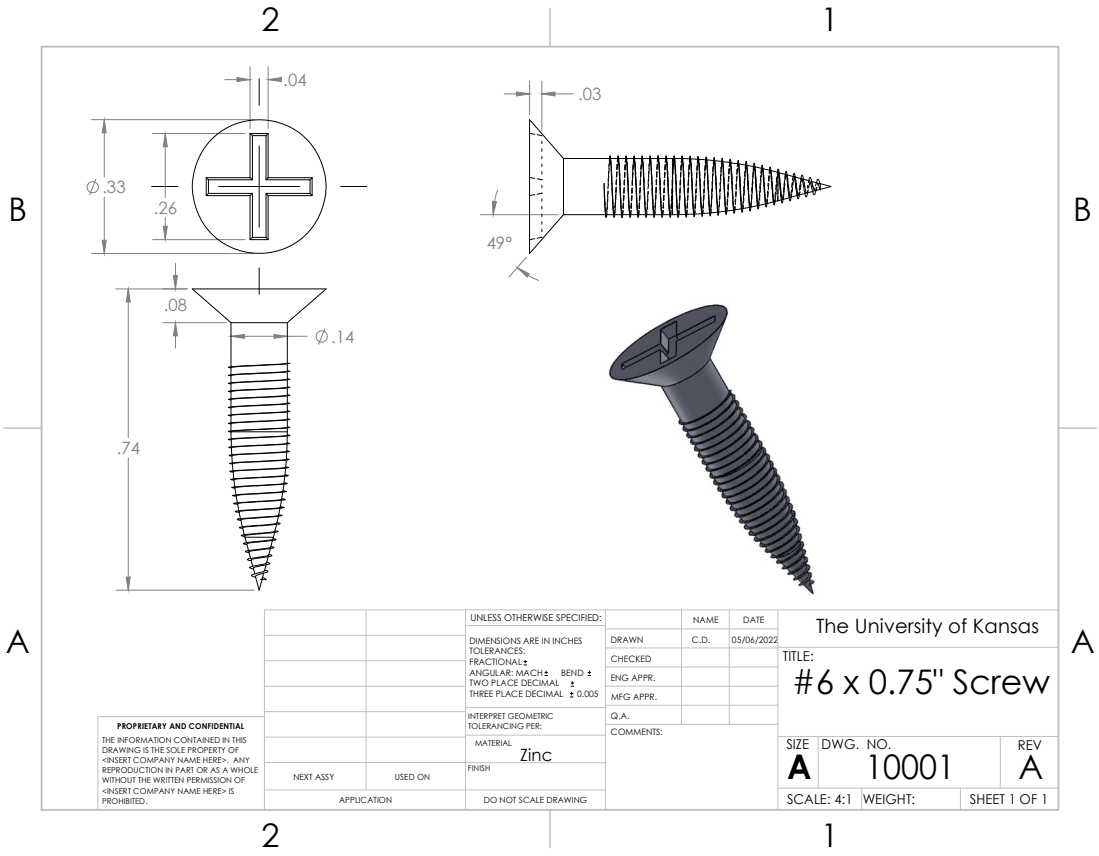
15790B – Coupling (x1)



- *Material:*
  - *Polyvinyl Chloride (PVC)*
- *Tools required:*
  - *N/A*

i. No machining necessary.

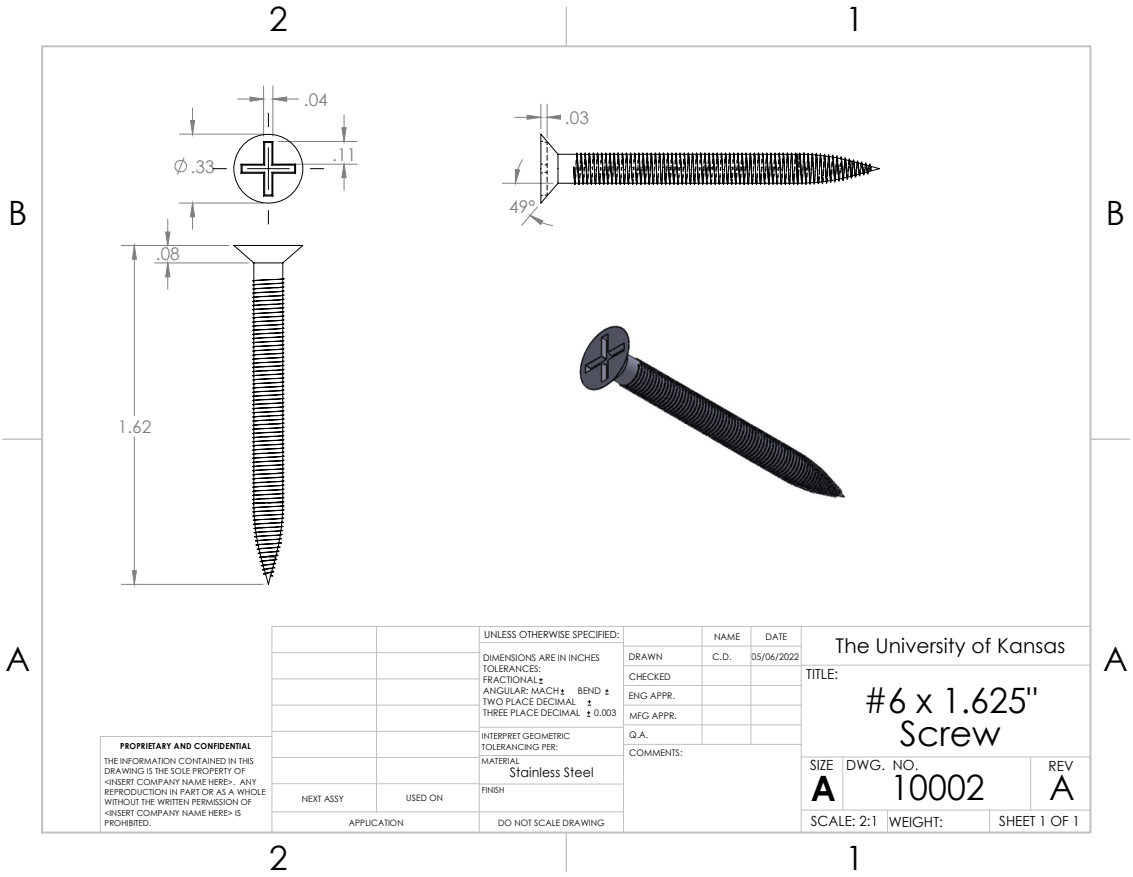
10001A - #6 x 0.75” Screw (x12)



- *Material:*
  - *ZNC PHL FLT #6 3/4" Wood Screw*
- *Tools required:*
  - *N/A*

ii. No machining necessary.

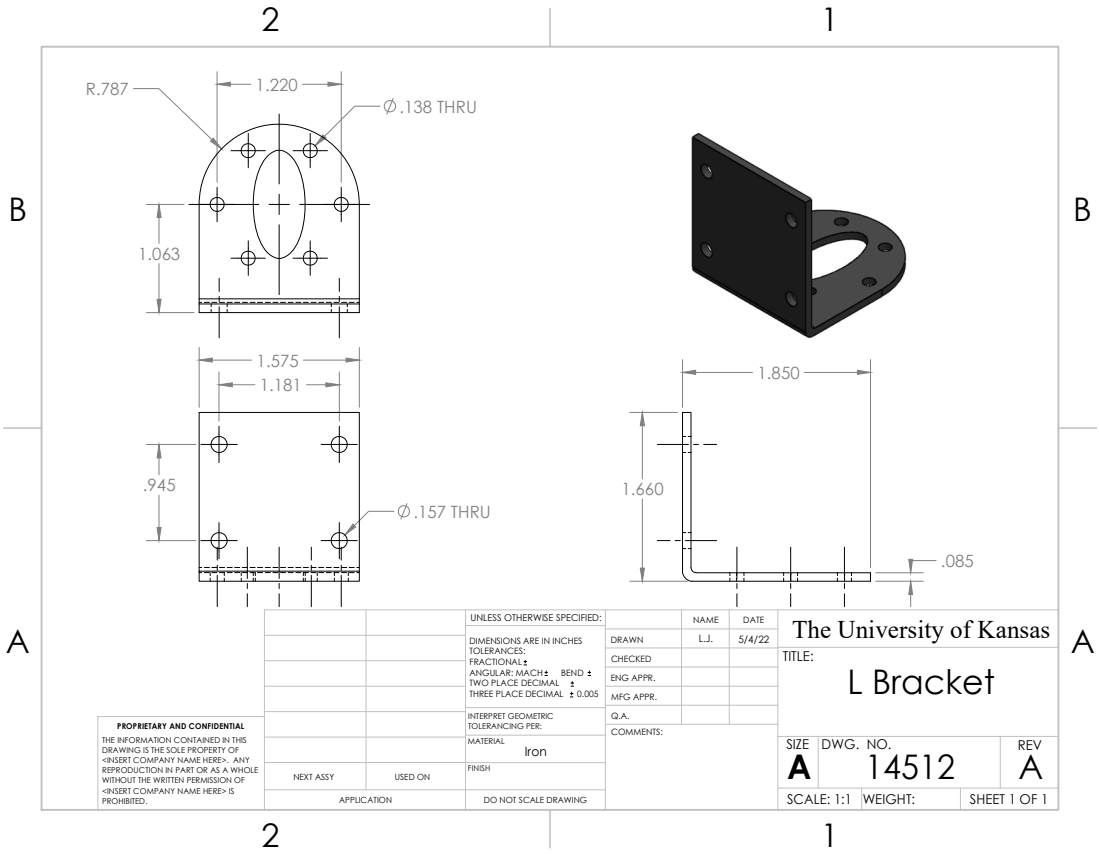
10002A - #6 x 1.625" Screw (x2)



- *Material:*
  - *#6 1 5/8 in. Wood Screw*
- *Tools required:*
  - *N/A*

iii. No machining necessary.

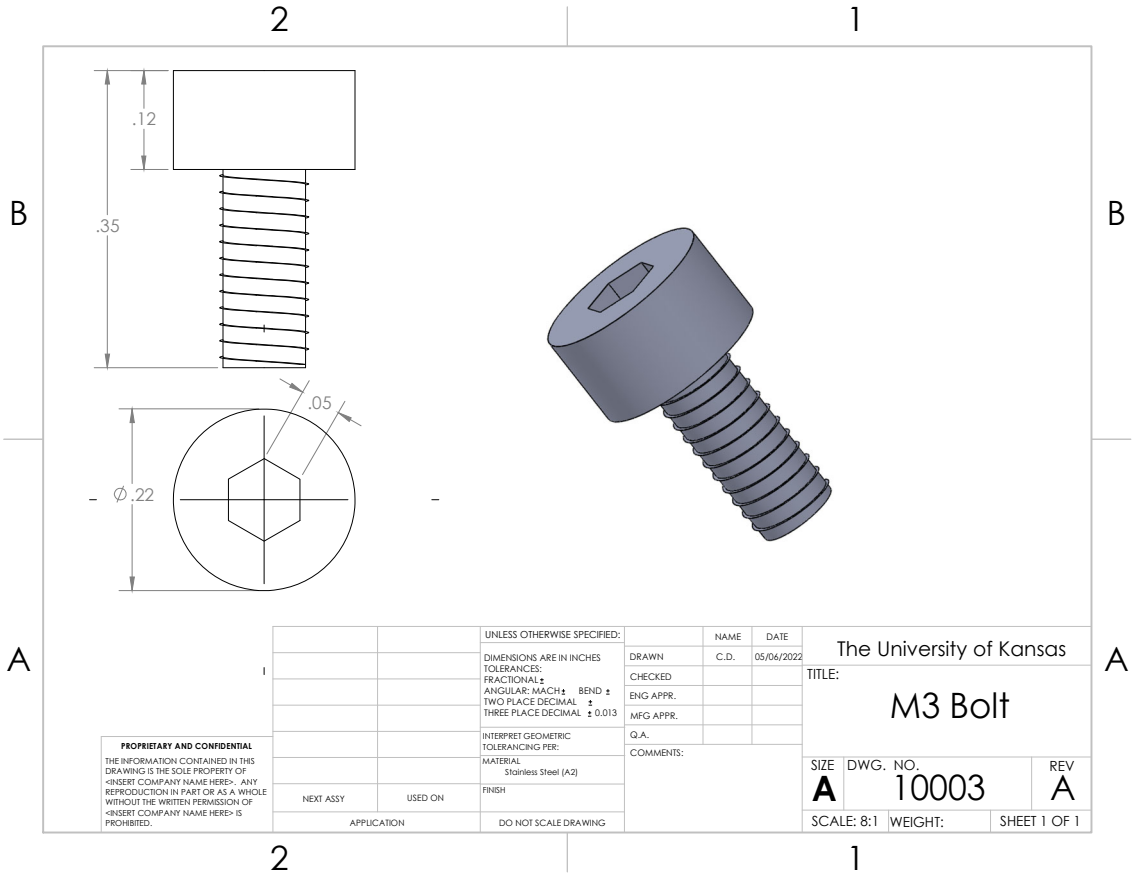
14512A – L Bracket (x1)



- *Material:*
  - *Black 37mm DC Gear Motor Mounting Bracket*
- *Tools required:*
  - *N/A*

iv. No machining necessary.

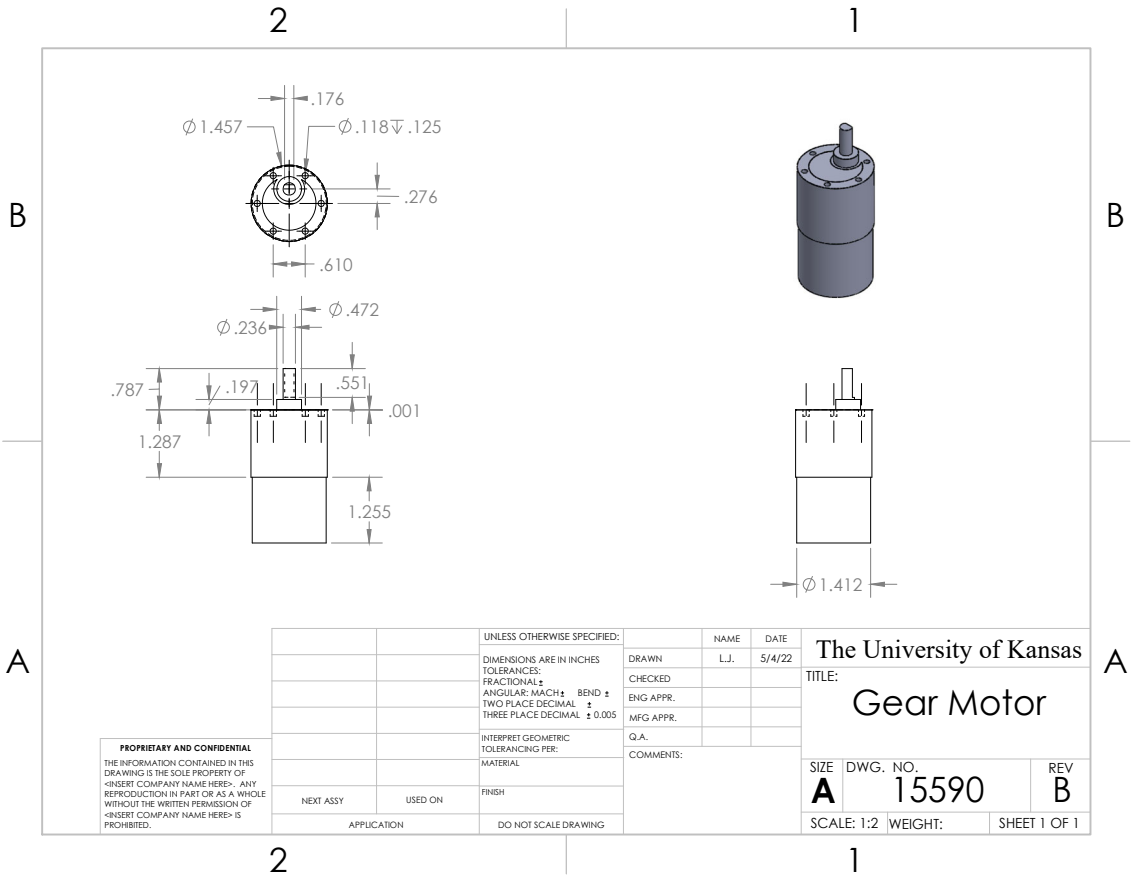
10003A – M3 Bolt (x10)



- *Material:*
  - *M3 x 3mm Screw*
- *Tools required:*
  - *N/A*

v. *No machining necessary.*
   a. *Comes with L Bracket (14512A).*

15590B – Gear Motor (x1)

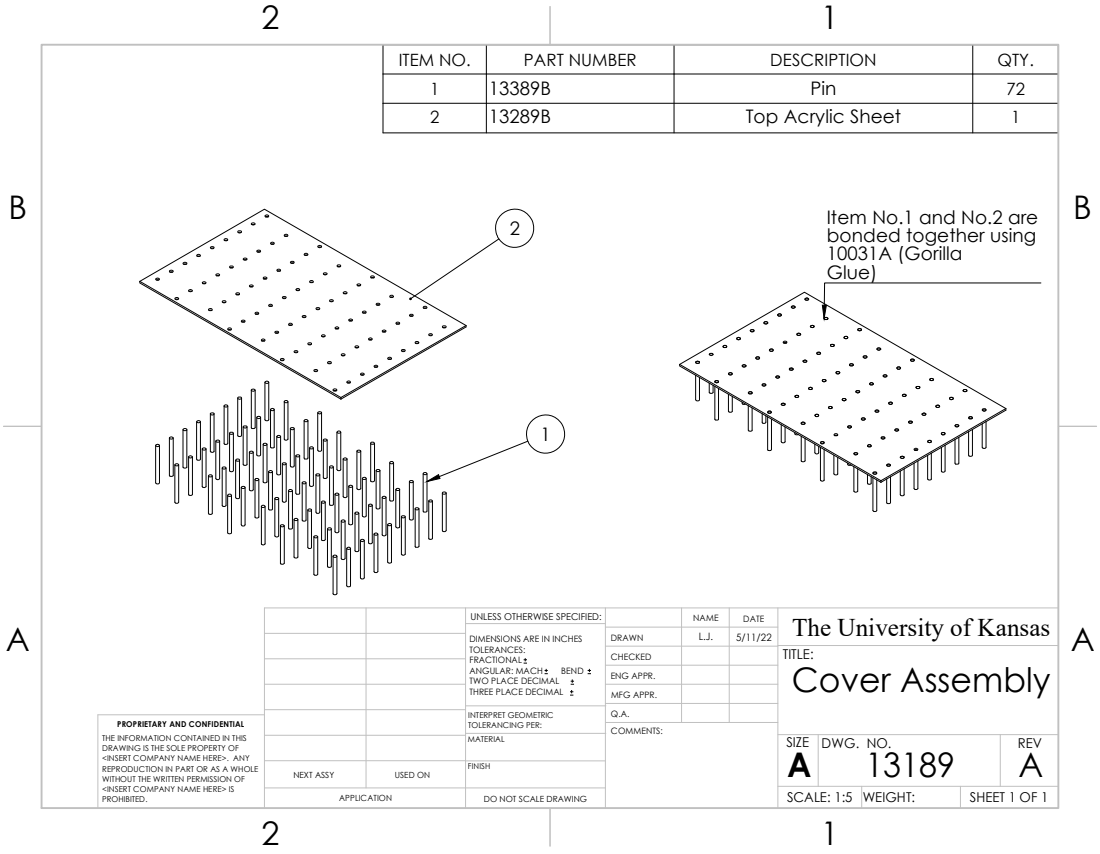


- *Material:*
  - *Geartisan DC 12V 5RPM Micro Speed Reduction Gear Motor*
- *Tools required:*
  - *N/A*

vi. No machining necessary.

ASSEMBLY STEPS

1. **COVER ASSEMBLY – 13189A**



Step 1 – Add Pins

Components:

- *13389B – Pin (x72)*
- *13289B – Top Acrylic Sheet (x1)*

Tools/Accessories:

- *10021A (Clear Gorilla Glue)*

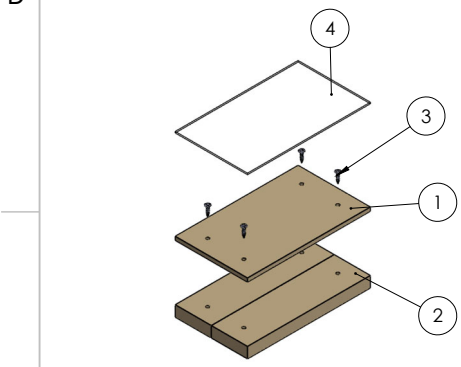
i. *Glue a Pin (13389B) into each hole on the Top Acrylic Sheet (13289B) using Gorilla Glue (10031A). The top of the Pin (13389B) should be flush with the top of the Top Acrylic Sheet (13289B).*

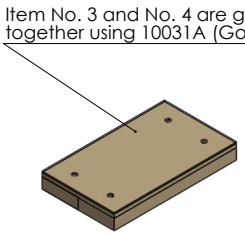
ii. *Optional: Leave 0.1” of each Pin (13389B) sticking out the top of the Top Acrylic Sheet (13289B) for added touch sensory.*

- *Ensure the Pins (13389B) are not sharp – sand edges if needed.*

2. FLAT ASSEMBLY – 11213A

ITEM NO.	PART NUMBER	DESCRIPTION	QTY.
1	11356B	Plywood Flat	1
2	14312C	Flat Support	2
3	10001A	#6 x 0.75" Screw	4
4	11556A	Acrylic Flat	1





UNLESS OTHERWISE SPECIFIED:
DIMENSIONS ARE IN INCHES
TOLERANCES:
FRACTIONAL ±
ANGULAR: MACH ± BEND ±
TWO PLACE DECIMAL ±
THREE PLACE DECIMAL ±
INTERPRET GEOMETRIC TOLERANCING PER:
MATERIAL
FINISH
NEXT ASSY | USED ON
APPLICATION | DO NOT SCALE DRAWING

	NAME	DATE
DRAWN	L.J.	5/11/22
CHECKED		
ENG APPR.		
MFG APPR.		
Q.A.		
COMMENTS:		

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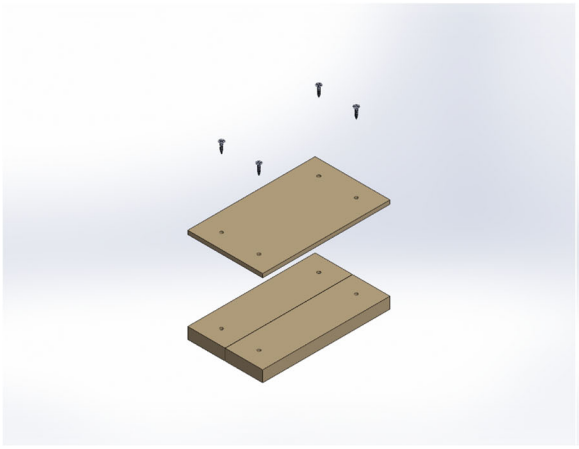
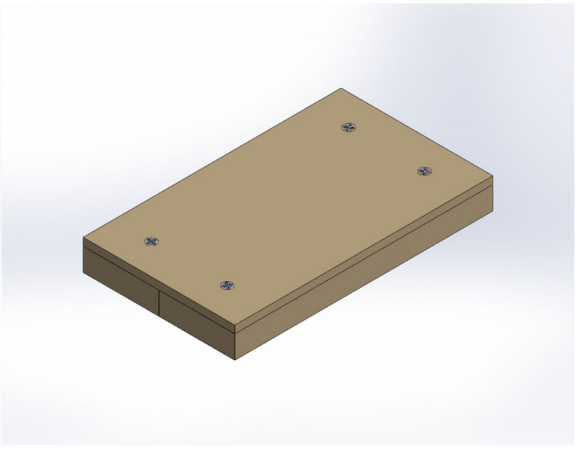
The University of Kansas
TITLE: Flat Assembly
SIZE A | DWG. NO. 11213 | REV A
SCALE: 1:5 | WEIGHT: | SHEET 1 OF 1

Step 1 – Screw in Support Blocks





Components:

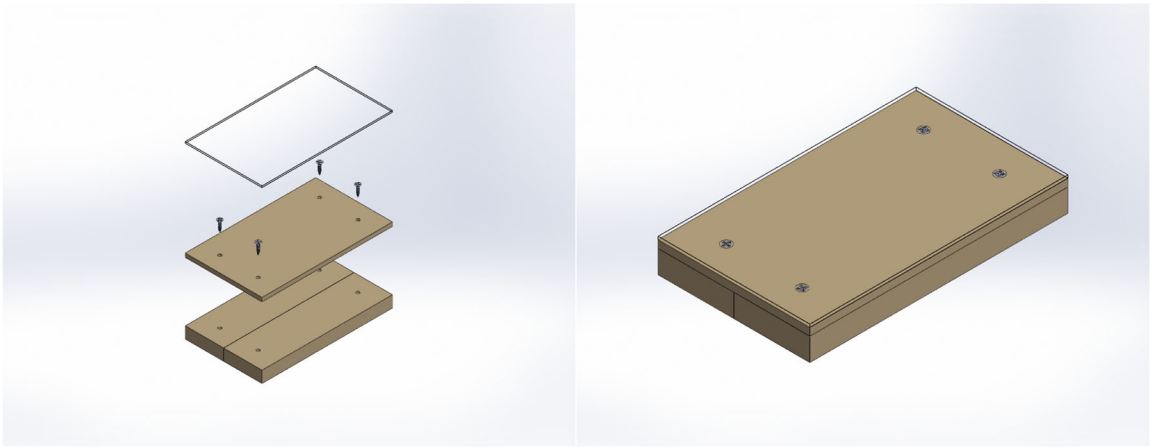
- *11356B – Plywood Flat (x1)*
- *14312C – Flat Support (x2)*
- *10001A – #6 x 0.75” Screw (x4)*

Tools/Accessories:

- *Electric Drill*

i. *Line up the holes of one of the Flat Supports (14312C) with two holes on the Plywood Flat (11356B).*
ii. *Use an electric drill to screw in one #6 x 0.75” Screw (10001A) into each hole.*
iii. *Line up the holes of the second Flat Support (14312C) with the other two holes on the Plywood Flat (11356B).*
iv. *Use an electric drill to screw in one #6 x 0.75” Screw (10001A) into each hole.*

Step 2 – Glue on Acrylic Flat



Components:

- *11556A – Acrylic Flat (x1)*

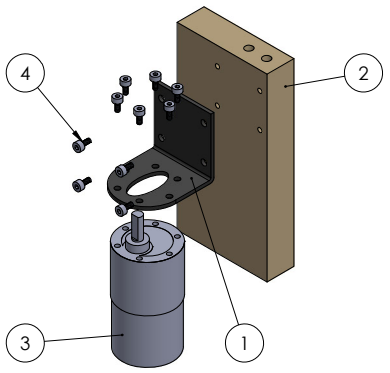
Tools/Accessories:

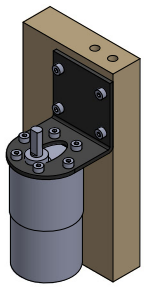
- *10031A (Gorilla Glue)*

i. *Put Gorilla Glue (10031A) all over the top of the Plywood Flat (11356B).*
ii. *Place the Acrylic Flat (11556A) on top, ensuring all the edges line up.*
    a. *Use clamps to hold the pieces tightly together until the glue dries.*

3. MOTOR ASSEMBLY – 15601A

ITEM NO.	PART NUMBER	DESCRIPTION	QTY.
1	14512A	L Bracket	1
2	14412C	Motor Support	1
3	15590B	Gear Motor	1
4	10003A	M3 Bolt	10





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	L.J.	5/11/22
CHECKED		
ENG APPR.		
MFG APPR.		
Q.A.		

COMMENTS:

NEXT ASSY | USED ON | APPLICATION

The University of Kansas

TITLE: Motor Assembly

SIZE A | DWG. NO. 15601 | REV A

SCALE: 1:5 | WEIGHT: | SHEET 1 OF 1

Step 1 – Screw in Motor

Components:

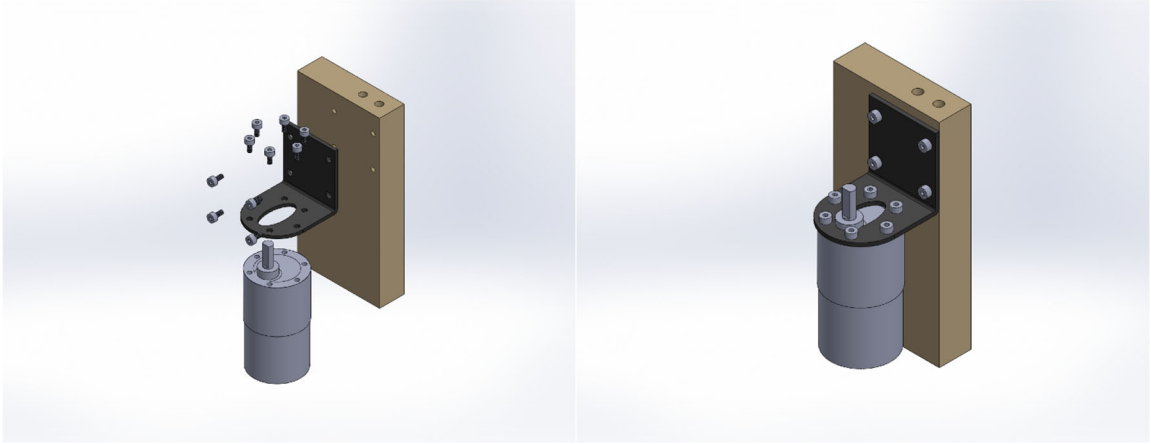
- *14512A – L Bracket (x1)*
- *15590B – Gear Motor (x1)*
- *10003A – M3 Bolt (x6)*

Tools/Accessories:

- *2.5mm Hex Key Allen Wrench*

i. *Place the male piece on the Gear Motor (15590B) inside the ellipse of the L Bracket (14512A).*
ii. *Line up the holes on the top of the Gear Motor (15590B) with the holes on the L Bracket (14512A), ensuring the male piece on the Gear Motor (15590B) is on the far side from the angle of the L Bracket (14512A).*
iii. *Screw in one M3 Bolt (10003A) into each of the six holes using a 2.5mm Hex Key Allen Wrench.*

Step 2 – Screw in Motor Support



Components:

- *14412C – Motor Support (x1)*
- *10003A – M3 Bolt (x4)*

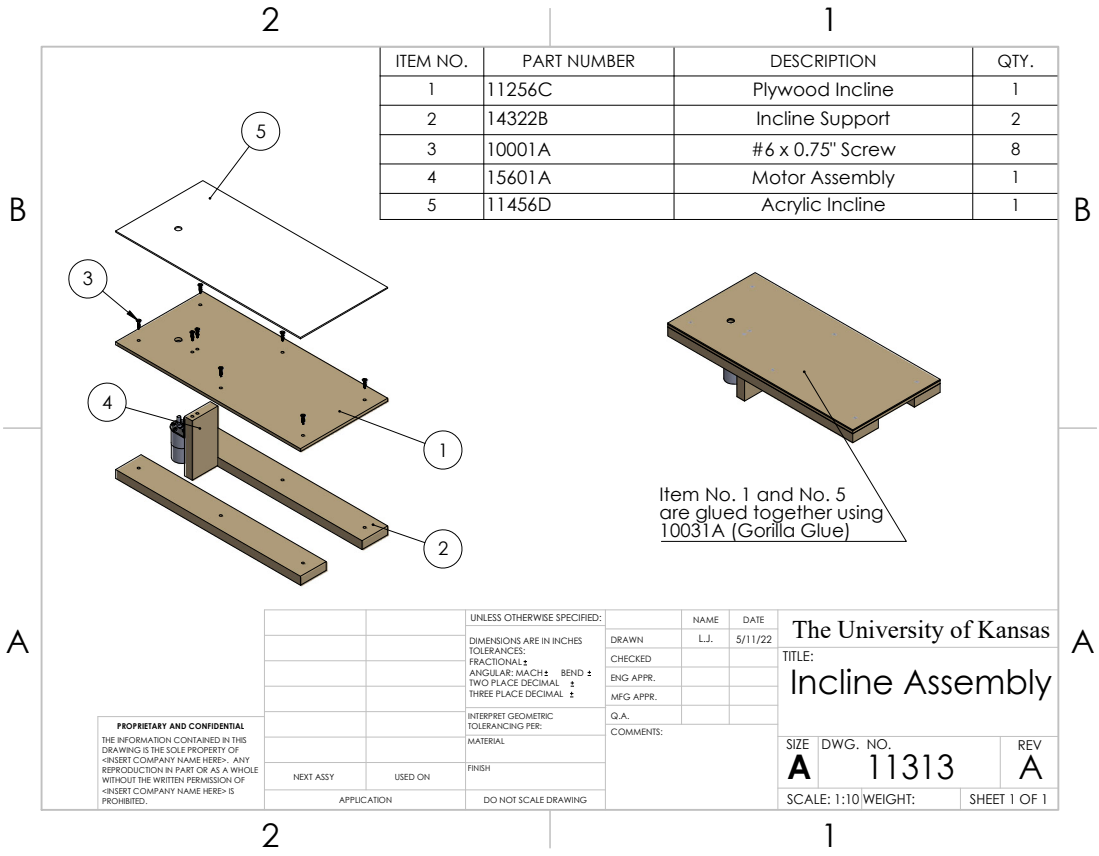
Tools/Accessories:

- *2.5mm Hex Key Allen Wrench*

i. *Align the holes on the square side of the L Bracket (14512A) with the four holes on the large flat face of the Motor Support (14412C).*
   a. *Ensure the Gear Motor (15590B) hangs downwards, aligning with long end of the Motor Support (14412C).*

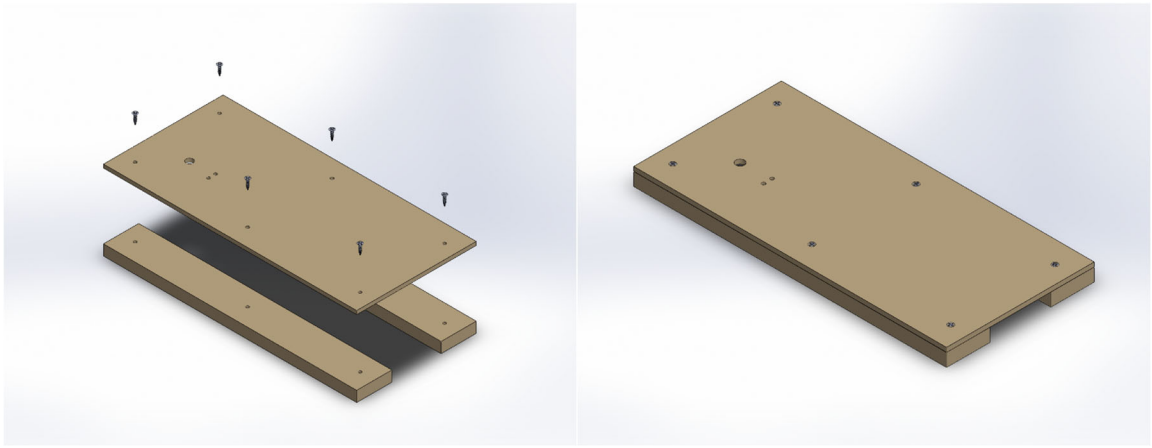
ii. *Screw in one M3 Bolt (10003A) into each of the four holes using a 2.5mm Hex Key Allen Wrench.*

4. Incline Assembly – 11313A



ITEM NO.	PART NUMBER	DESCRIPTION	QTY.
1	11256C	Plywood Incline	1
2	14322B	Incline Support	2
3	10001A	#6 x 0.75" Screw	8
4	15601A	Motor Assembly	1
5	11456D	Acrylic Incline	1

Step 1 – Screw in Flat Supports



Components:

- *11256C – Plywood Incline (x1)*

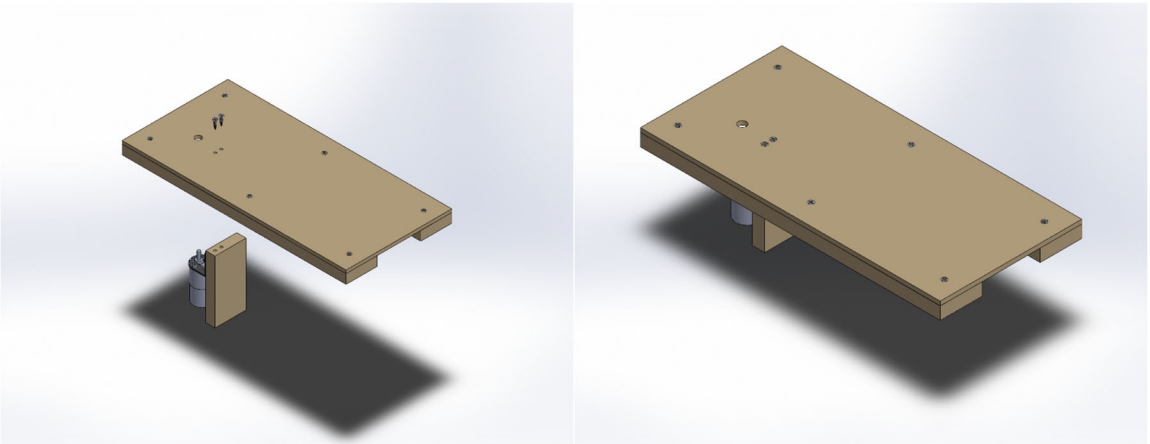
- *14322B – Incline Support (x2)*
- *10001A – #6 x 0.75” Screw (x6)*

Tools/Accessories:

- *Electric Drill*

i. *Line up the holes on each Incline Support (14322B) with the associated holes near the sides of the Plywood Incline (11256C).*
ii. *Use an electric drill to screw in one #6 x 0.75” Screw (10001A) into each hole.*

Step 2 – Screw in Motor Assembly



Components:

- *15601A – Motor Assembly*
- *10001A – #6 x 0.75” Screw (x2)*

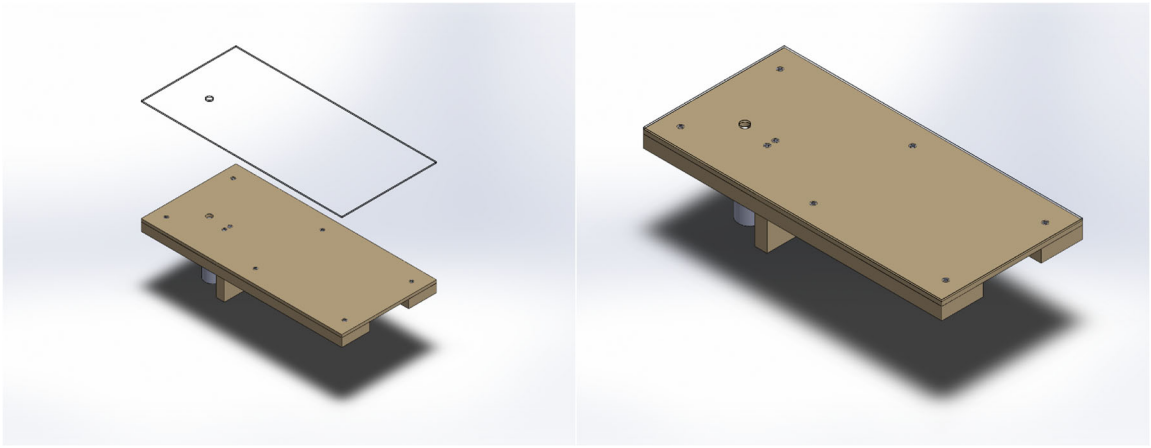
Tools/Accessories:

- *Electric Drill*

iii. *Line up the two holes on the top of the Motor Assembly (15601A) with the two holes in the middle of the Plywood Incline (11256C).*
    a. *Ensure the Motor Assembly (15601A) is on the same side as the Incline Supports (14322B).*
    b. *Ensure the Gear Motor (15590B) is facing towards the large hole on the Plywood Incline (11256C).*

iv. *Use an electric drill to screw in one #6 x 0.75" Screw (10001A) into each hole.*

Step 3 – Glue on Acrylic Incline



Components:

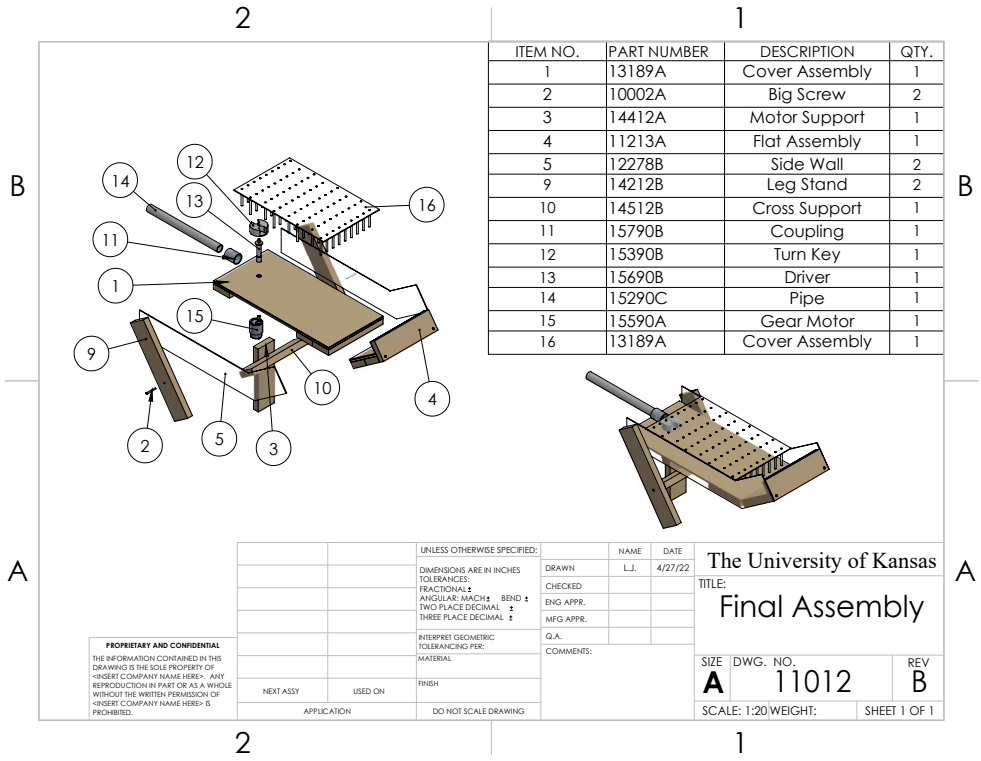
- *11456D – Acrylic Incline (x1)*

Tools/Accessories:

- *10031A – Gorilla Glue*

i. *Put Gorilla Glue (10031A) all over the top of the Plywood Incline (11256C).*
ii. *Place the Acrylic Incline (11456D) on top, ensuring all the edges and the large hole line up.*
    a. *Use clamps to hold the pieces tightly together until the glue dries.*

5. FINAL ASSEMBLY – 11012B



ITEM NO.	PART NUMBER	DESCRIPTION	QTY.
1	13189A	Cover Assembly	1
2	10002A	Big Screw	2
3	14412A	Motor Support	1
4	11213A	Flat Assembly	1
5	12278B	Side Wall	2
9	14212B	Leg Stand	2
10	14512B	Cross Support	1
11	15790B	Coupling	1
12	15390B	Turn Key	1
13	15690B	Driver	1
14	15290C	Pipe	1
15	15590A	Gear Motor	1
16	13189A	Cover Assembly	1

UNLESS OTHERWISE SPECIFIED:
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TOLERANCES:
FRACTIONAL ±
ANGULAR: MACH ± BEND ±
TWO PLACE DECIMAL ±
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MATERIAL
FINISH
NEXT ASSY | USED ON
APPLICATION | DO NOT SCALE DRAWING

	NAME	DATE
DRAWN	L.J.	4/27/22
CHECKED		
ENG APPR.		
MFG APPR.		
Q.A.		
COMMENTS:		

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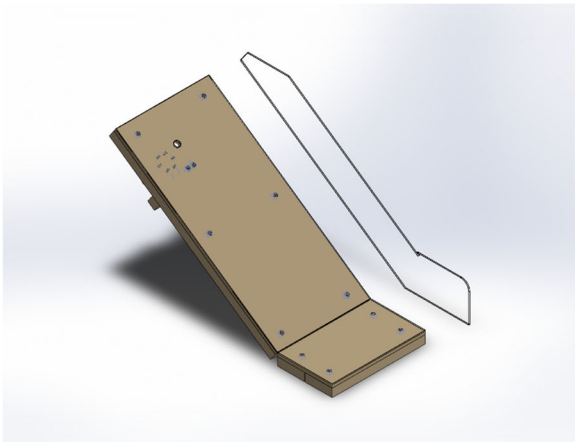
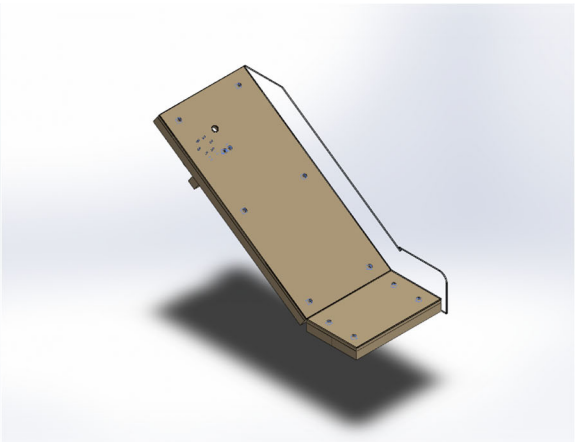
The University of Kansas
TITLE: Final Assembly
SIZE A | DWG. NO. 11012 | REV B
SCALE: 1:20 | WEIGHT: | SHEET 1 OF 1

Step 1 – Glue on First Side Wall





Components:

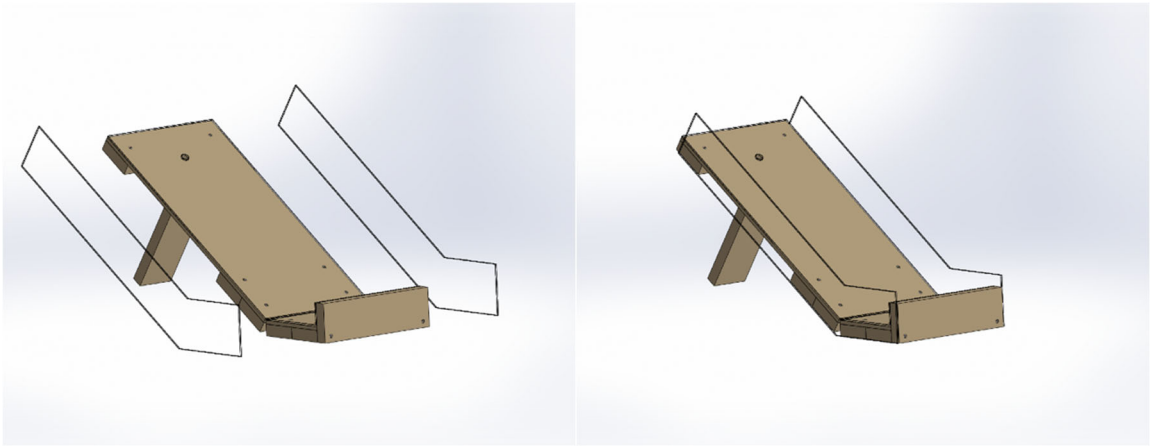
- *12278C – Side Wall (x1)*

Tools/Accessories:

- *10031A – Gorilla Glue*

i. *Place Gorilla Glue (10031A) all over one of the side edges of the assembly thus far.*
ii. *Align the bottom edge of the Side Wall (12278C) with the bottom edges of the Flat Assembly (11213A) and bottom edge of the Incline Assembly (11313A)*
    a. *Ensure the top edge of the Incline Assembly (11313A) aligns with the top of edge of the Side Wall (12278C).*
    b. *Ensure the bottom edge of the Incline Assembly (11313A) and the edge of the Flat Assembly (11213A) are touching at an angle.*
iii. *Use clamps to hold the pieces tightly together until the glue dries.*

Step 2 – Glue on Second Side Walls



Components:

- *12278C – Side Wall (x1)*

Tools/Accessories:

- *10031A – Gorilla Glue*

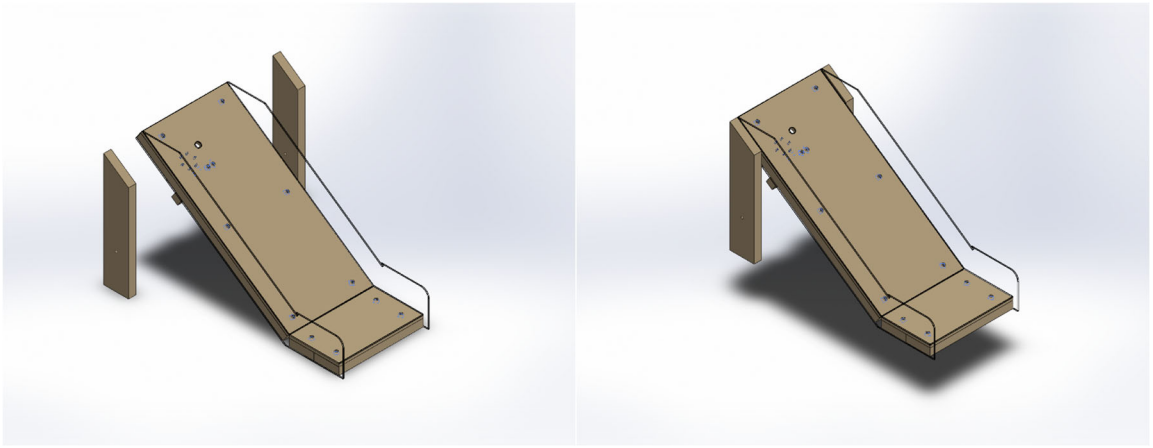
iv. *Place Gorilla Glue (10031A) all over the other side edges of the assembly thus far.*

v. *Align the bottom edge of the Side Wall (12278C) with the bottom edges of the Flat Assembly (11213A) and bottom edge of the Incline Assembly (11313A)*

   a. *Ensure the top edge of the Incline Assembly (11313A) aligns with the top of edge of the Side Wall (12278C).*

vi. *Use clamps to hold the pieces tightly together until the glue dries.*

Step 3 – Glue on Leg Stands



Components:

- *14212C – Leg Stand (x2)*

Tools/Accessories:

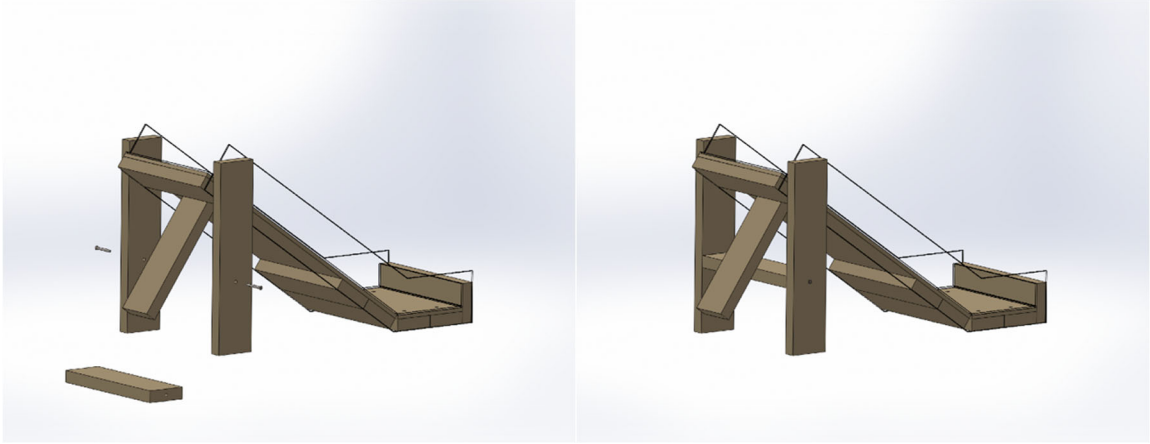
- *10031A – Gorilla Glue*

i. *Place Gorilla Glue (10031A) all over the side of the Side Walls (12278C) where the Leg Stands will touch.*

ii.

iii. *the Leg Stands (14212C)*

Step 4 – Screw in Cross Support



Components:

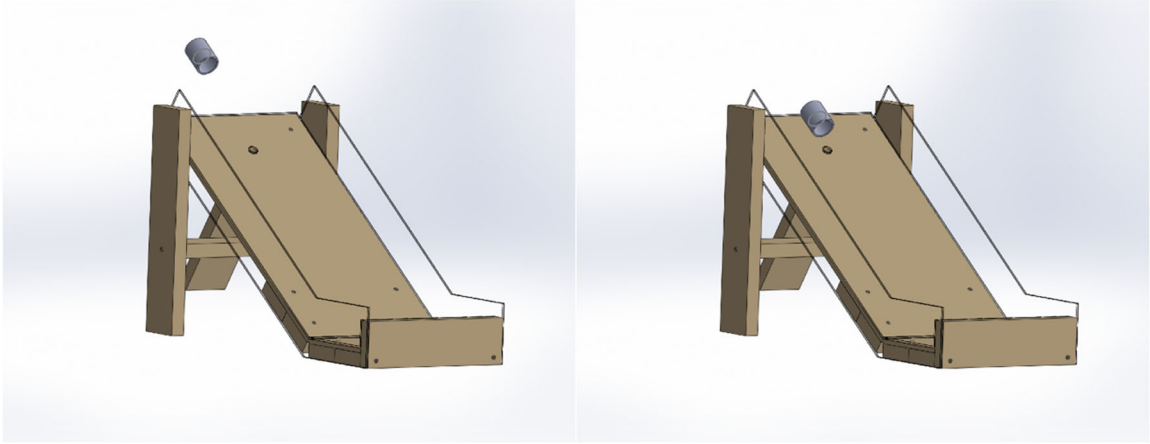
- *14512B – Cross Support (x1)*
- *10002A – Big Screw (x2)*

Tools/Accessories:

- *Electric Drill*

i. *Place the Cross Support (14512B) in between the Leg Stands (14212B) and align the side holes of the Cross Support (14512B) with the holes on each Leg Stand (14212B), ensuring the large flat face of the Cross Support (14512B) is facing upwards.*
ii. *Use an electric drill to screw in one Big Screw (10002A) into each hole.*

Step 5 – Glue on Coupling



Components:

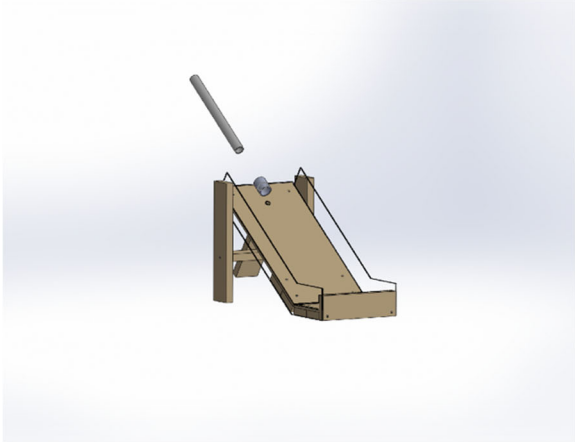
- *15790B – Coupling (x1)*

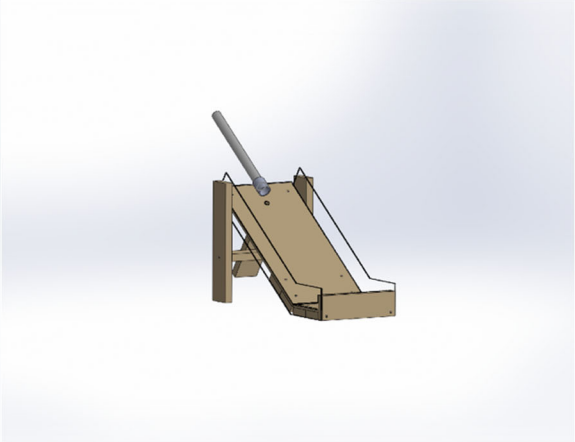
Tools/Accessories:

- *J-B Weld Plastic Bonder*

i. *Cover one side of the Coupling (15790B) with J-B Weld Plastic Bonder.*
ii. *Place the Coupling (15790B) ***insert inches from top*** from the top of the incline and centered.*
    a. *Use clamps to hold the pieces tightly together until the glue dries.*

Step 6 – Insert Pipe





Components:

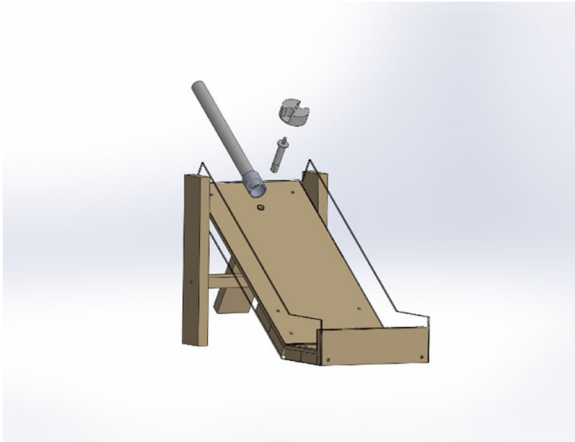
- *15290C – Pipe (x1)*

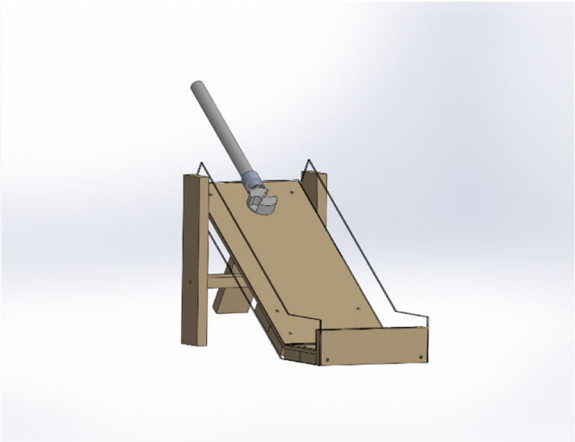
Tools/Accessories:

- *N/A*

i. *Place one end of the Pipe (15290C) all the way into the Coupling (15790B) until the edges are flush with each other.*
   a. *No glue or screws required.*

Step 7 – Insert Driver and Turn Key





Components:

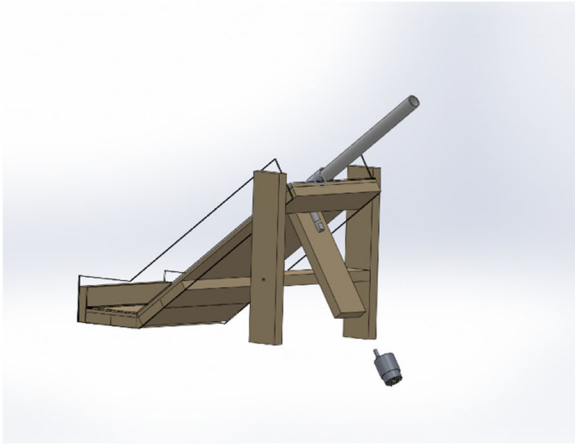
- *15690B – Driver (x1)*
- *15390B – Turn Key (x1)*

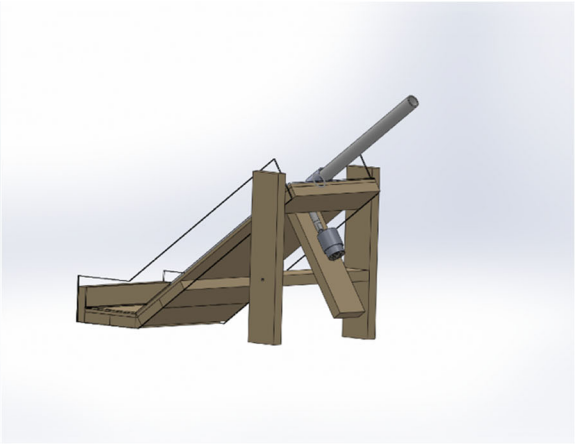
Tools/Accessories:

- *N/A*

i. *Place the thick end of the Driver (15690B) into the large hole on the incline until the disk near the top lays flush with the incline.*
ii. *Place the Turn Key (15390B) on top of the Driver (15690B), ensuring they align.*
    a. *No glue or screws required.*

Step 8 – Insert Gear Motor





Components:

- *15590A – Gear Motor (x1)*

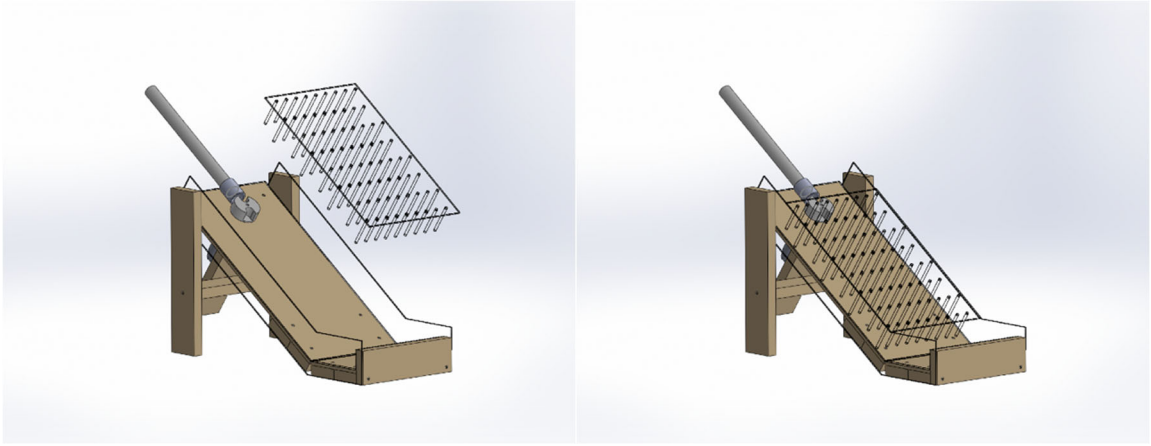
Tools/Accessories:

- *Clear Gorilla Glue*

i. *Place the male end of the Gear Motor (15590A) inside the female end of the Driver (15690B) and note where the motor sits on the Motor Support (14412A).*

ii. *Place Clear Gorilla Glue anywhere on the Motor Support (14412A) where the Gear Motor (15590A) touches and place the male end of the Gear Motor (15590A) back into the female end of the Driver (15690B).*
    a. *Use clamps to hold the pieces tightly together until the glue dries.*

Step 9 – Place on the Cover Assembly



Components:

- *13189A – Cover Assembly (x1)*

Tools/Accessories:

- *Velcro*

i. *Cut two 1” pieces of Velcro.*
ii. *Place one side of each piece of Velcro in the middle of the top edge of the Side Walls (12278B).*
iii. *Place the other side of each Velcro piece in the corresponding spot on the edge of the Cover Assembly (13189A).*
iv. *Place the Cover Assembly (13189A) on top of the Side Walls (12278B) with the Velcro pieces touching.*
    a. *Ensure the Pins (13389B) do not touch the Turn Key (15390B) when the Cover Assembly (13189A) is attached.*

ELECTRICAL SET UP

Components:

- *Powerlink3 Switchbox*
- *Soulbay 12V power adapter*
- *Gear Reduction Motor*
- *Wires*

Tools/Accessories:

- *Screwdriver*

Step 1 - Connecting Wires to the Gear Motor

- *Using the hooks on the wires, connect the positive end of the LED connection to the negative end of the gear motor.*
- *Connect the Negative end of the LED connection to the positive port of the gear motor.*
- *Wires can be screwed into the LED adapter using a screwdriver to ensure the connection is secure.*

Step 2 - Connect Power Adapter and Switch to Switchbox

- *A switch of the user's choice can be connected to the Switchbox via the 3.5mm jack at the base of the switchbox.*
- *The power adapter will then be plugged into one of the outlet ports on the same side of the switch.*

ALTERNATIVES

ALL WOOD

For a cheaper option, all the clear acrylic, except for the Top Acrylic Sheet (13289B), could be removed or replaced by wood.

- *Removed:*
    i. *11556A – Acrylic Flat*
    ii. *11656A – Acrylic End Wall*
    iii. *11456C – Acrylic Incline*
- *Modified:*
    i. *13389B – Pin → 3/16” Wooden Dowel Rod*
    ii. *12278B – Side Wall → 0.25” Thick Plywood*

Acrylic was used in the original design to protect the wood from the paint and to allow for easier clean up. If the acrylic parts were to be removed or replaced by wood, it is recommended to add a water proofing coating over any wood that’ll be exposed to the paint.

Note: the Top Acrylic Sheet (13289B) cannot be replaced by a wood alternative as it allows for the user to see through it and watch the art be created.

ALL ACRYLIC

For a sleeker design, the entire device could be constructed out of purely clear acrylic. The current design utilizes wood as a cheap option to ensure structural integrity. Replacing the wood parts with a thick acrylic, at least a ½” thick, would keep the structural integrity of the device, but would be an expensive modification.

COVER ASSEMBLY

The cover assembly is set up like a typical plinko board, having staggered rows of pins all the way down. The pins could be placed into any design pattern on the top acrylic sheet, such as having them placed in circles, to help the marbles create more unique patterns on the paper as they roll down the incline and bounce off the pins. Since the cover assembly is detachable from the rest of the device, different cover assemblies could easily be switched out whenever desired.

Part #	Rev	Description	Material	Quantity
11012	B	Final Assembly	-	1
13189	A	Cover Assembly	-	1
13289	B	Top Acrylic Sheet	0.093 in. Crystal Clear OPTIX Acrylic	1
13389	B	Pin	3/16 in. Clear Acrylic Rod	72
11213	A	Flat Assembly	-	1
11356	B	Plywood Flat	0.25 in. Plywood	1
11556	A	Acrylic Flat	0.093 in. Crystal Clear OPTIX Acrylic	1
14312	C	Flat Support	1x3 in. Eastern White Pine Furring Board	2
10001	A	#6 x 0.75" Screw	#6 3/4 in. Screw Flat Heat Phillips Screw	4
11313	A	Incline Assembly	-	1
11256	C	Plywood Incline	0.25 in. Plywood	1
11456	D	Acrylic Incline	0.093 in. Crystal Clear OPTIX Acrylic	1
14322	B	Incline Support	1x3 in. Eastern White Pine Furring Board	2
10001	A	#6 x 0.75" Screw	#6 3/4 in. Screw Flat Heat Phillips Screw	8
15601	A	Motor Assembly	-	1
15590	B	Gear Motor	DC 12V 5RPM Micro Speed Reduction Gear Motor	1
10003	A	M3 Bolt	M3 x 6mm Screw	10
16512	A	L Bracket	Black 37mm DC Gear Motor Mounting Bracket	1
14412	C	Motor Support	1x3 in. Eastern White Pine Furring Board	1
12278	C	Side Wall	0.093 in. Crystal Clear OPTIX Acrylic	2
14212	C	Leg Stand	1x3 in. Eastern White Pine Furring Board	2
12378	C	End Wall	1/2" thick Clear Plexiglass	1
14512	C	Cross Support	1x3 in. Eastern White Pine Furring Board	1
10002	A	#6 x 1.625" Screw	#6 1.625 Wood Screws	2
15290	C	Pipe	3/4 in. Polyvinyl Chloride (PVC)	1
15390	B	Turn Key	3D Print Filament	1
15690	C	Driver	3D Print Filament	1
15790	B	Coupling	3/4 in. Polyvinyl Chloride (PVC)	1
10021	A	Plastic Bonder	J-B Weld Clear Epoxy	1
10031	A	Gorilla Glue	Clear Gorilla Glue	1
20012	A	PowerLink3 Switchbox	AbleNet PowerLink3 Switchbox	1
20022	A	Power Adapter	SoulBay 30W Universal AC/DC Adapter	1
20032	A	Wires	Mini Hooks to Breadboard Male Jumper Wires	2