Training I

Mechanical Tools & Processes

Safety Considerations

Safety glasses are required in the shop.

No open toed shoes are allowed in the shop.

Do not use machinery unless supervised.

Objectives

1. Mechanical Tools

   Understand:

   - Measurement tools, Power tools, hand tools

   Demonstrate:

   - Drilling a hole, Tapping a hole
   - Cutting metal, Riveting metal together
   - Cutting metal
   - Pneumatics tubing connections

Parts and Tool Storage

- Staying organized will allow you to work more effectively

- Return tools to a tool tray or the toolbox after use

- Parts for an assembly should be stored in a part tray

Wrenches

Open End Wrench

Box Wrench

Ratchet Box

Adjustable Wrench

Ratchet Wrench

Wrenches

Allen Wrench

T Handle Allen Wrench

Hand Nut Driver

Clamping

Vise Grips

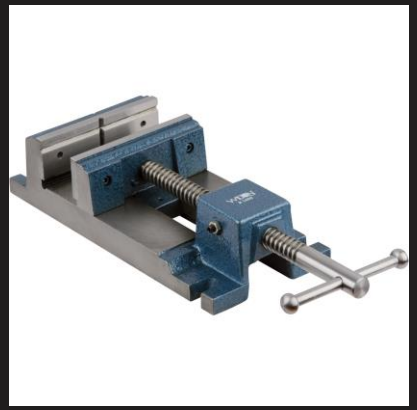
Grip Release

Pressure Adjustment

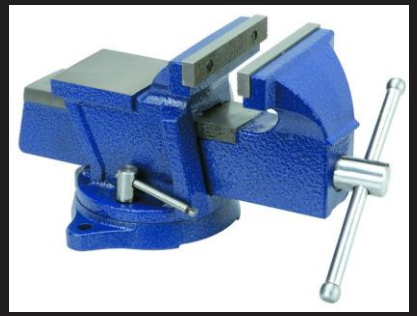
Release

Bar Clamp

C Clamp



Drill Press Vise



Bench Vise

Deburring and Files

Metal Files

Edges

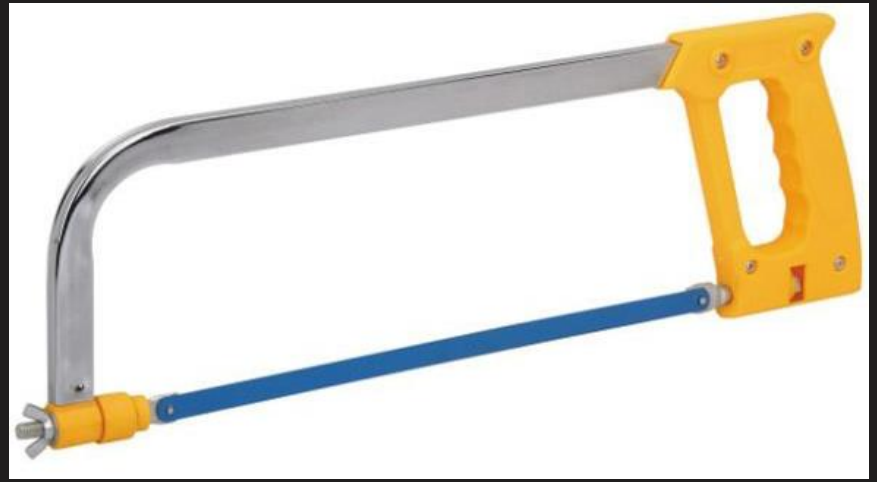
Deburring Tool

Holes

Metal Cutting

Tube Cutter

Scores tube



Hack Saw

Press and Pulling

Bearing Puller

Used to pull bearings off of shafts or press gears onto shafts

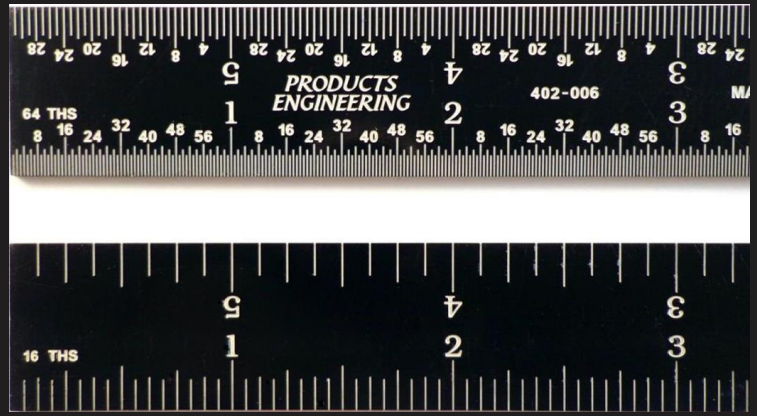
Arbor Press

Measurement

Know what your scale is

Tab move ensure it is in the right spot

FRACTIONS TO DECIMALS					
1/32	=	0.03125	17/32	=	0.53125
1/16	**=**	**0.0625**	**9/16**	**=**	**0.5625**
3/32	=	0.09375	19/32	=	0.59375
1/8	**=**	**0.125**	**5/8**	**=**	**0.625**
5/32	=	0.15625	21/32	=	0.65625
3/16	**=**	**0.1875**	**11/16**	**=**	**0.6875**
7/32	=	0.21875	23/32	=	0.71875
1/4	**=**	**0.25**	**3/4**	**=**	**0.75**
9/32	=	0.28125	25/32	=	0.78125
5/16	**=**	**0.3125**	**13/16**	**=**	**0.8125**
11/32	=	0.34375	27/32	=	0.84375
3/8	**=**	**0.375**	**7/8**	**=**	**0.875**
13/32	=	0.40625	29/32	=	0.90625
7/16	**=**	**0.4375**	**15/16**	**=**	**0.9375**
15/32	=	0.46875	31/32	=	0.96875
1/2	**=**	**0.5**			



Square

Make sure your marks are square

Measurement

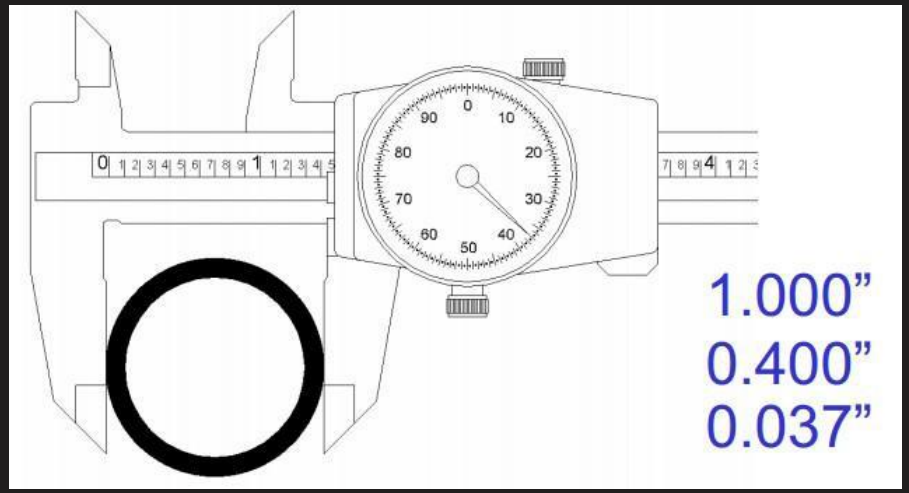
Know what your scale is

Inside Caliper

Digital Caliper

Outside Caliper

Dial Caliper



Drills

1. Make sure material is secured in a vise or drill table
2. Lower drill slowly and raise slowly
3. Clear chips

Depth Stop

Chuck

Drill speed

Forward/Reverse

Mentor needs to be present for drill press

Drilling a Hole

1. Measure
2. Center punch
3. Pilot drill
4. Drill
5. Debur

Drill Guide

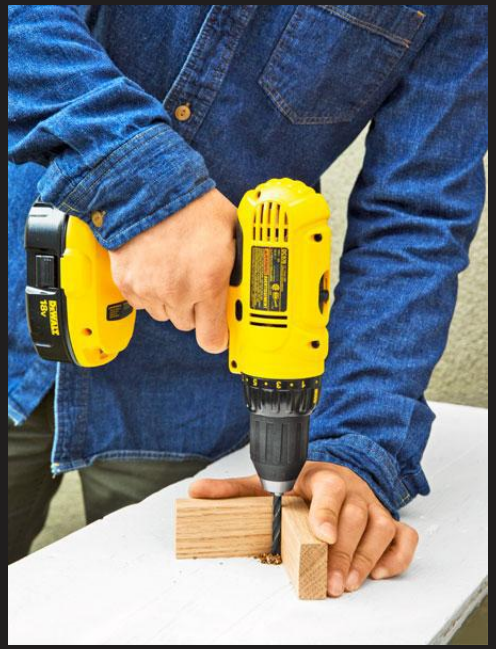
Metal Scribe

Center Punch

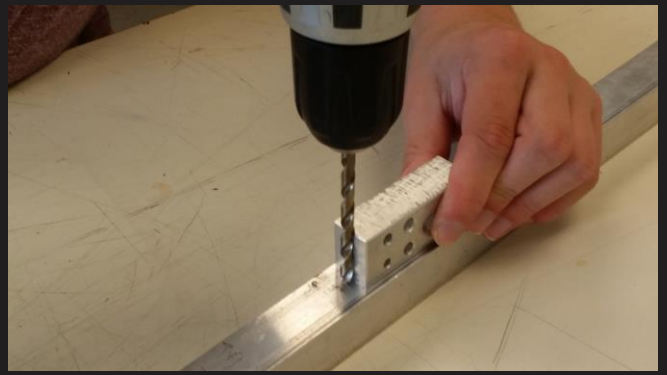
Imperial Tap Drill Chart

Machine Screw Size		Number of Threads Per Inch	Minor Dia.	Tap Drills				Clearance Hole Drills			
				Aluminum, Brass & Plastics 75% Thread		Stainless Steel, Steels & Iron 50% Thread		All Materials			
								Close Fit		Free Fit	
No. or Dia.	Major Dia.			Drill Size	Decimal Equiv.	Drill Size	Decimal Equiv.	Drill Size	Decimal Equiv.	Drill Size	Decimal Equiv.
0	.0600	80	.0447	3/64	.0469	55	.0520	52	.0635	50	.0700
1	.0730	64	.0538	53	.0595	1/16	.0625	48	.0760	46	.0810
		72	.0560	53	.0595	52	.0635				
2	.0860	56	.0641	50	.0700	49	.0730	43	.0890	41	.0960
		64	.0668	50	.0700	48	.0760				
3	.0990	48	.0734	47	.0785	44	.0860	37	.1040	35	.1100
		56	.0771	45	.0820	43	.0890				

Drilling a Perpendicular Hole



Square L Bracket



Hand Drill/Tap Guide

Drill Guide

Screws and Drills

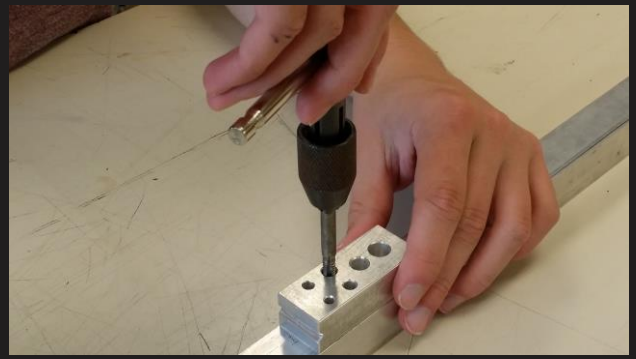
Machine Screw Size		Number of Threads Per Inch	Minor Dia.	Tap Drills				Clearance Hole Drills			
				Aluminum, Brass & Plastics 75% Thread		Stainless Steel, Steels & Iron 50% Thread		All Materials			
								Close Fit		Free Fit	
No. or Dia.	Major Dia.			Drill Size	Decimal Equiv.	Drill Size	Decimal Equiv.	Drill Size	Decimal Equiv.	Drill Size	Decimal Equiv.
0	.0600	80	.0447	3/64	.0469	55	.0520	52	.0635	50	.0700
1	.0730	64	.0538	53	.0595	1/16	.0625	48	.0760	46	.0810
		72	.0560	53	.0595	52	.0635				
2	.0860	56	.0641	50	.0700	49	.0730	43	.0890	41	.0960
		64	.0668	50	.0700	48	.0760				
3	.0900	48	.0734	47	.0785	44	.0860	37	.1040	35	.1100
		56	.0771	45	.0820	43	.0890				
4	.1120	40	.0813	43	.0890	41	.0960	32	.1160	30	.1285
		48	.0864	42	.0935	40	.0980				
5	.1250	40	.0943	38	.1015	7/64	.1094	30	.1285	29	.1360
		44	.0971	37	.1040	35	.1100				
6	.1380	32	.0997	36	.1065	32	.1160	27	.1440	25	.1495
		40	.1073	33	.1130	31	.1200				
8	.1640	32	.1257	29	.1360	27	.1440	18	.1695	16	.1770
		36	.1299	29	.1360	26	.1470				
10	.1900	24	.1389	25	.1495	20	.1610	9	.1960	7	.2010
		32	.1517	21	.1590	18	.1695				

8-32:
Screw Size-Thread/In

Drill Size:
Large number - Small diameter

Tapping a Hole

1. Determine the threads per inch of the screw
2. From the drill/tap chart select the correct drill bit and tap
3. Drill perpendicular hole and place tap in tap wrench
4. Use tapping oil to lubricate the tap
5. Turn tap forward until resistance then turn back to break the metal chips



Knowledge Challenge

1 Do you use a file like a saw? Why?

2 What is a tool tray used for?

3 Before cutting anything check …..?

4 Do you use a hammer with a center punch?

5 How do you drill a perpendicular hole?

6 What is more important in building robots – level or square?

Cutting Metal - Cut Off Saw

1. Mentor needs to be present
2. Put on face shield and ear muffs
3. Make sure aluminum is secure against back fence
4. Keep hands away from blade
5. Start in the up position
6. Lower saw slowly and cut slowly
7. Turn off saw before raising

Aluminum and plastics only

Safety lock and power switch

Back fence

Saw thickness is 1/16

Cutting Metal - Bandsaw

1. Mentor needs to be present
2. Place blade guard just over material being cut
3. Keep hands away from blade
4. Cut slowly
5. Turn off and brake saw blade when done

Blade guard

Knowledge Challenge

1 Name FIVE power tool safety rules.

2 What is the dress code for operating power tools?

3 Before cutting anything check …..?

4 Who has to be present when using cutting power tools?

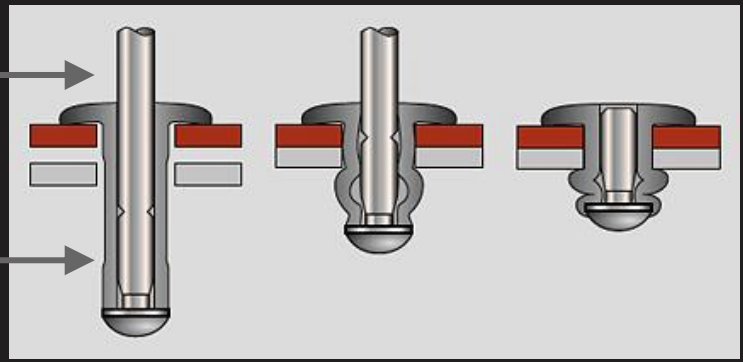
Riveting

Blind Riveting

1. Select drill size for the rivet
2. Select the correct sleeve for the rivet
3. Press rivet and rivet gun into the drilled hole
4. Squeeze rivet gun handle until mandrel snaps off

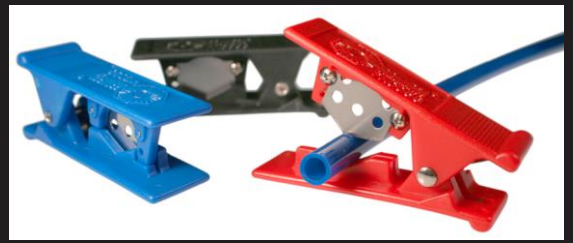
A good rivet should result in a tight fit

Common Sizes:
1/8, 3/16, 1/4



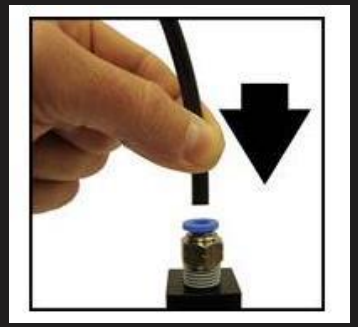
Pneumatics

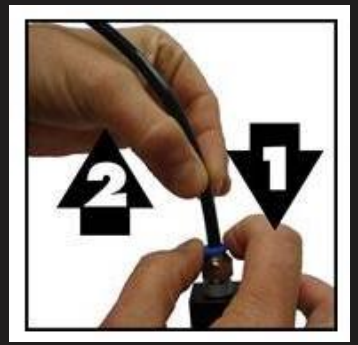
Pneumatic Tubing



Tubing Cutter

Press tubing until
you feel a snap





Leave last
2 thread clear
–wrap clockwise

Teflon tape helps
seal fitting

Robot and Power Safety

To power on robot:

- Designated safety person by the robot needs to be assigned
- Person powering on hollers: “POWER ON”
- Safety person will respond: “ALL CLEAR”
- Power will then be turned on

To enable software:

- Designated safety person by the robot needs to be assigned
- Person enabling software will holler: “ENABLING”
- Safety person will respond: “ALL CLEAR”
- Software will then be enabled

Robot Light:

Steady on -- robot has power and software is disabled
Flashing -- robot has power and software is enbaled

Knowledge Challenge

1 What direction do you apply Teflon tape?

2 How many wraps of Teflon tape do you put on?

3 Do you cut tubing with scissors?

4 Before cutting anything check …..?

5 What is Robot power up safety protocol?

Labs

Tap a hole

Drill a hole

Cut with the cut off saw

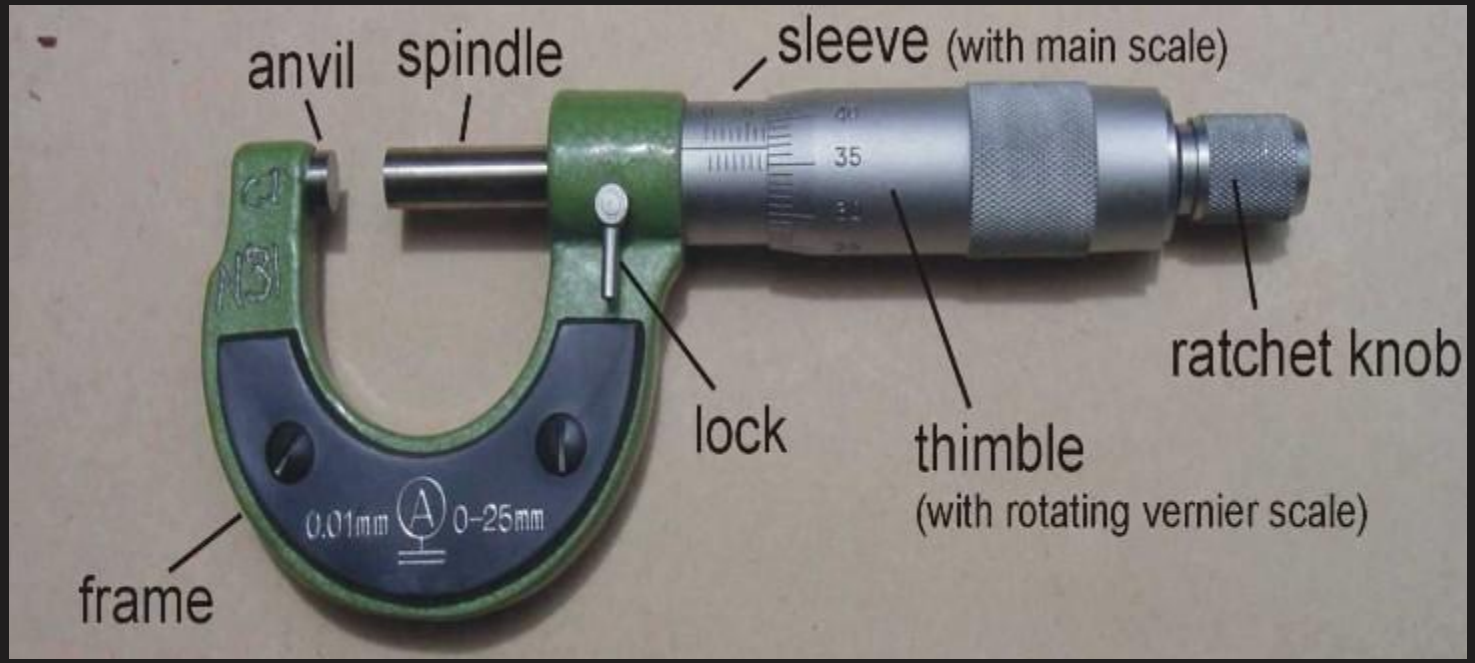
Cut with the band saw

Measure with a caliper

Connect a pneumatic tube to a connector

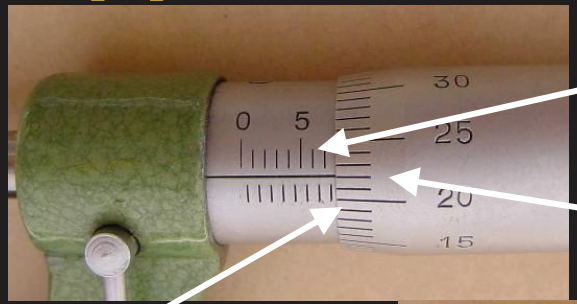
Appendix: Micrometer

Know what your scale is



Appendix: Micrometer

Know what your scale is



7mm

7.72mm -> 7mm + 0.50mm + 0.22mm

0.22mm

0.50mm

7.38mm -> 7mm + 0.38mm

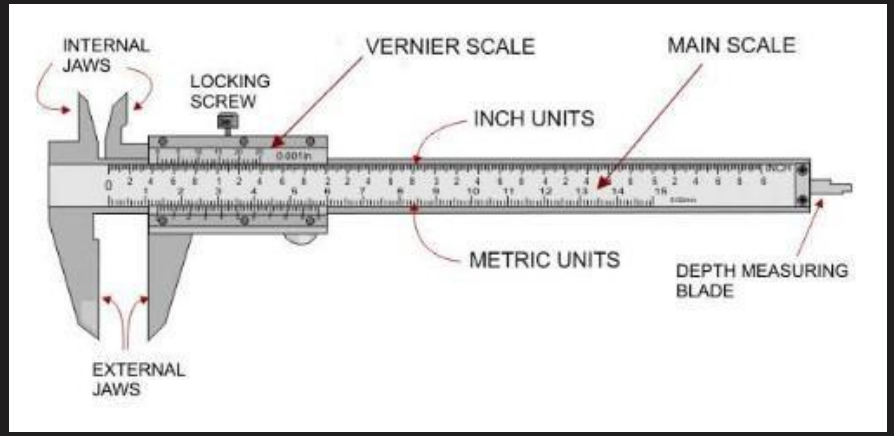
Didn’t pass 0.5mm

3.46mm

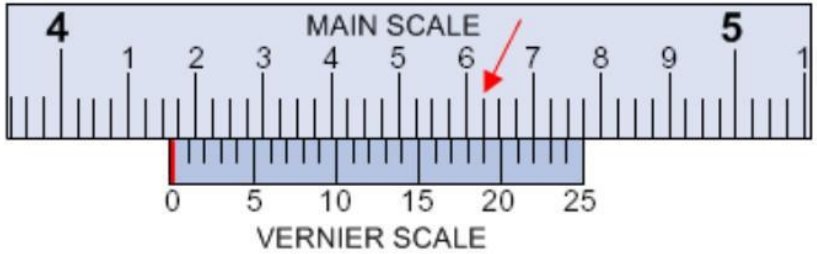
Can see 0.5mm

Appendix: Vernier Caliper

Know what your scale is



Example



- Inch 4.000 - Use the 0 line on the Vernier Scale.
- 1/10 0.100 - Use the 0 line on the Vernier Scale.
- .025 0.050 - Use the 0 line on the Vernier Scale.
- .001 0.019 - Select the first line on the Vernier Scale line that lines up with any line on the Main Scale.
- Total 4.169″

15