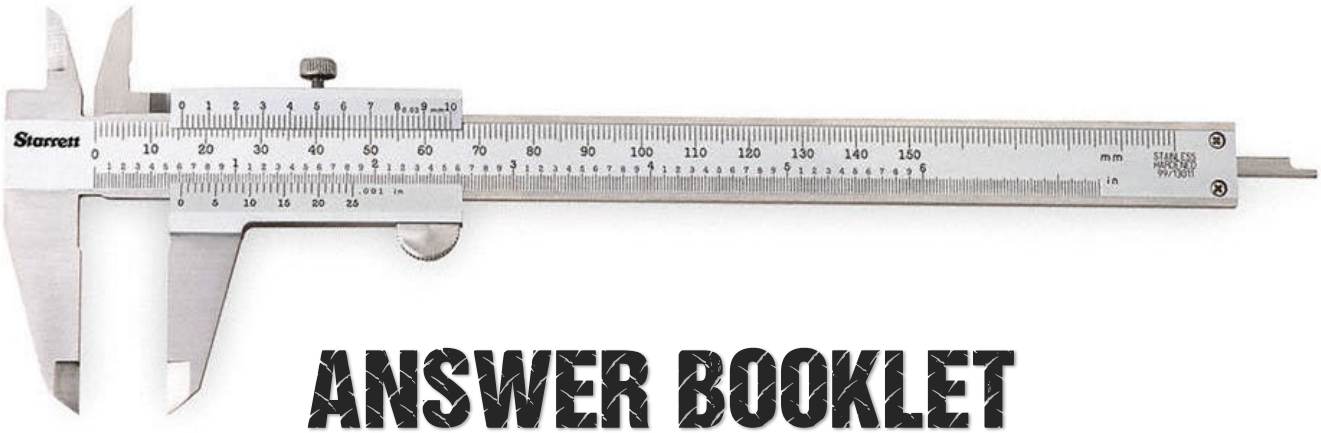
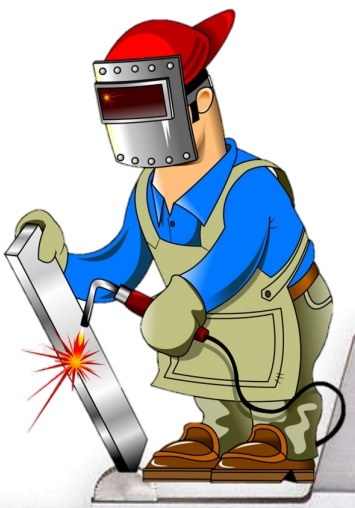


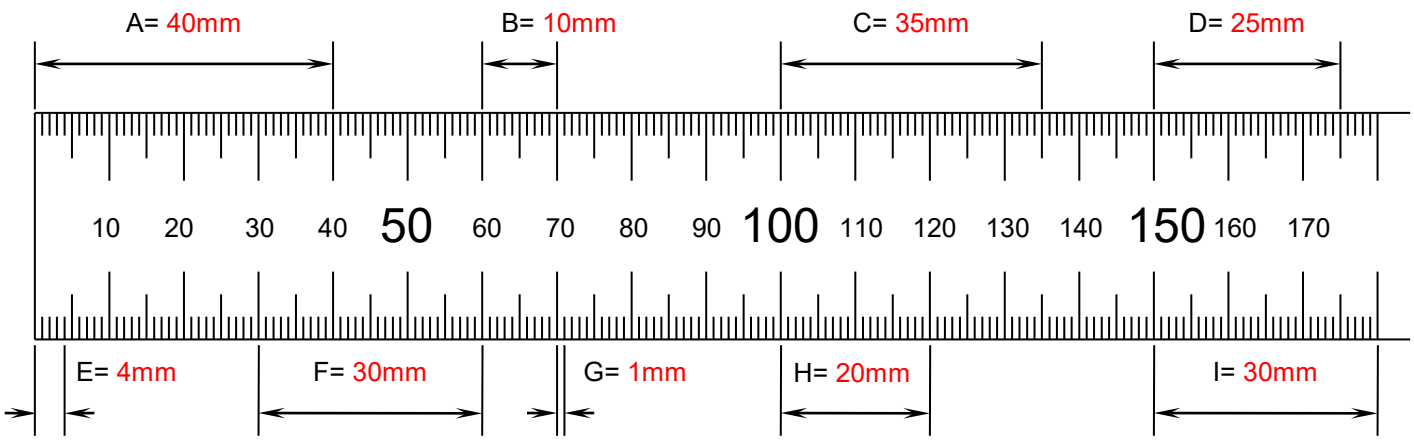
ANSWER BOOKLET

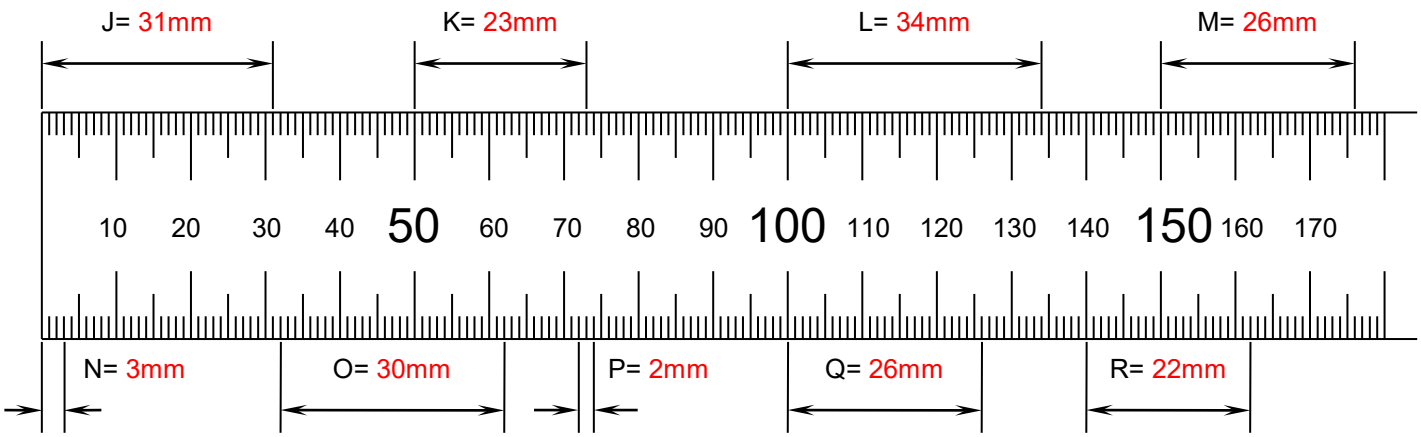
MEASURING MADNESS

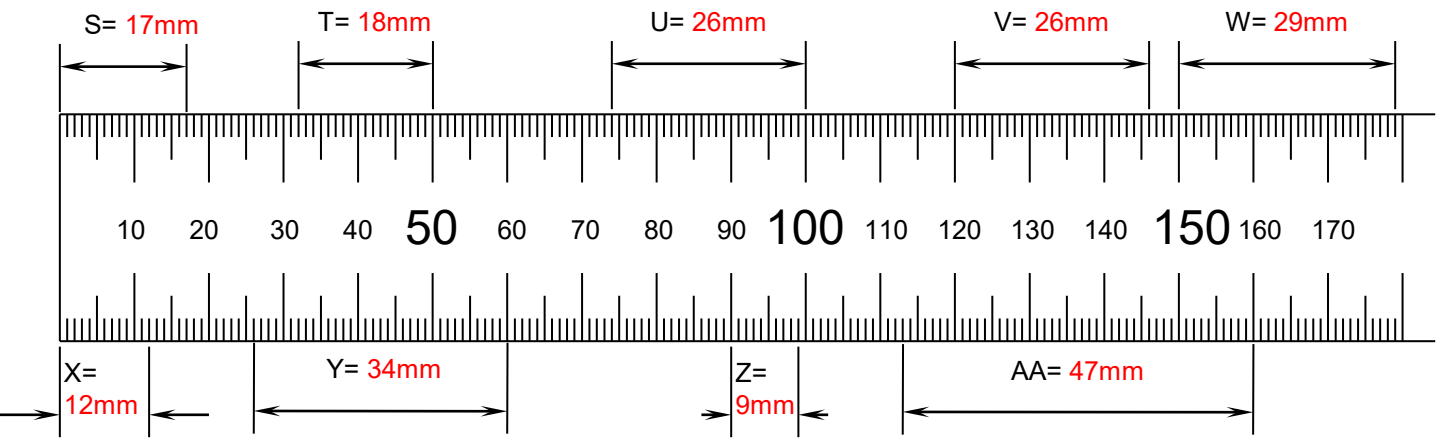


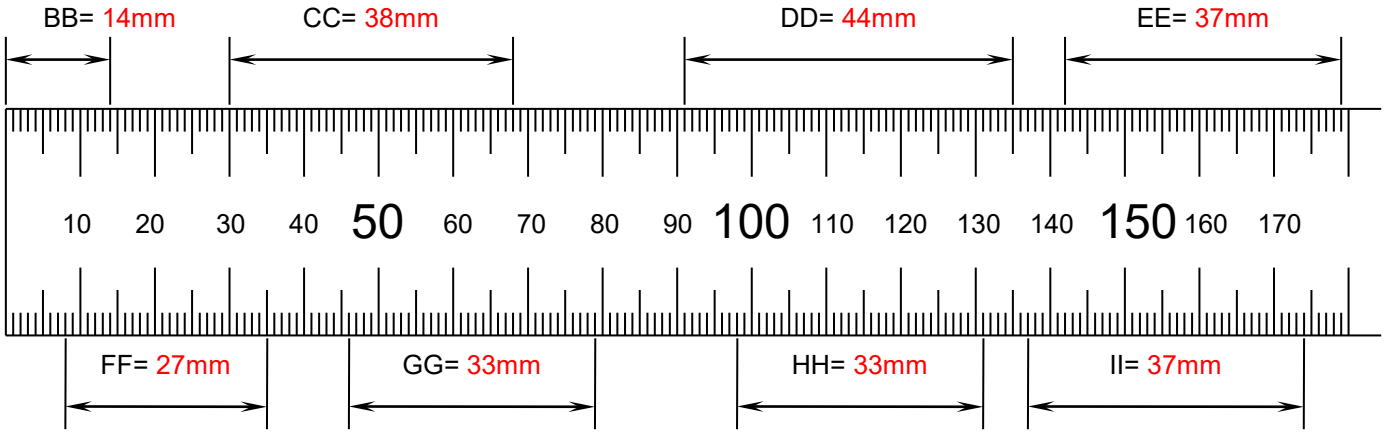
Name: _____ Class: _____

READING THE RULE

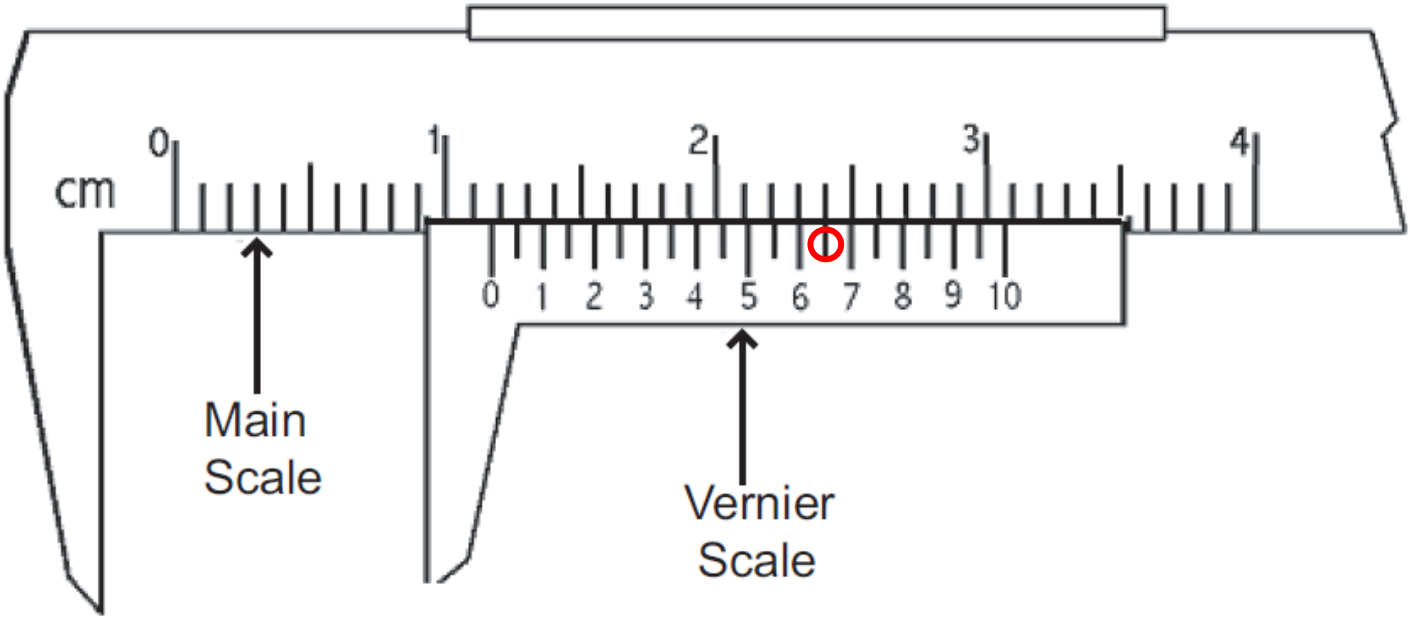








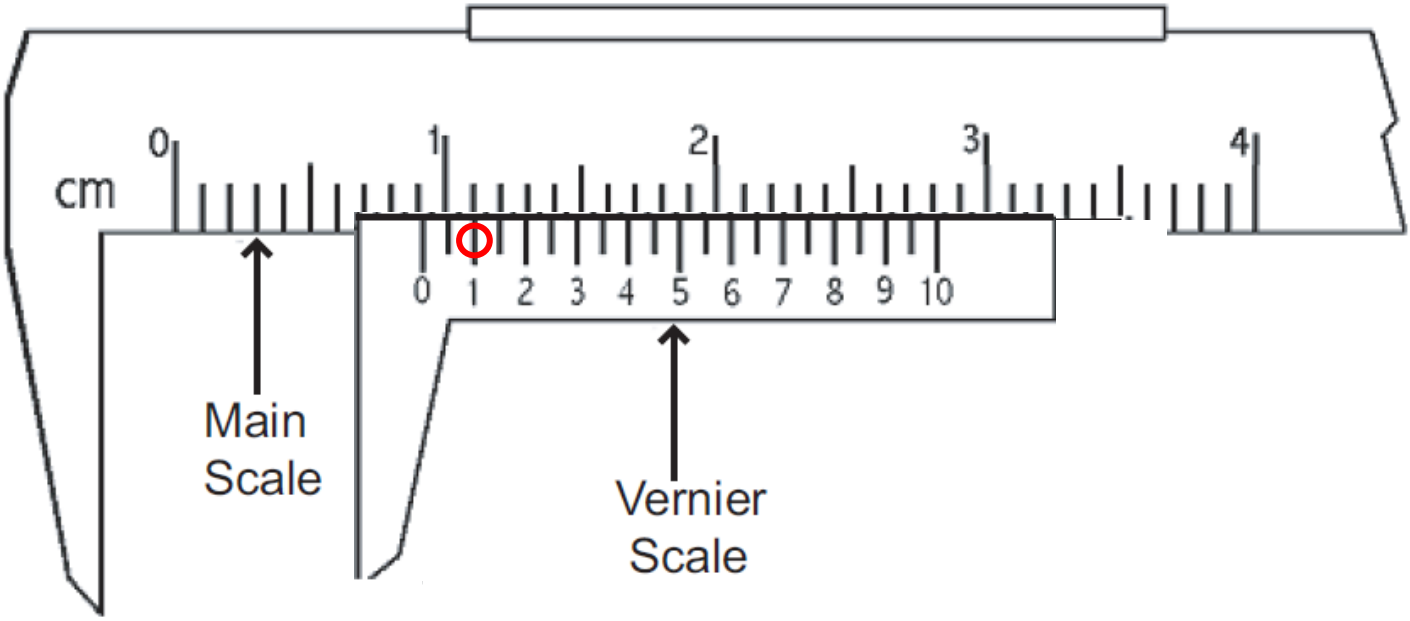
READING VERNIER CALIPERS



To understand the measurement readings from Vernier Caliper properly, you need to take two readings, first from the **Main Scale**, then from the **Vernier Scale**. For example, the Vernier Caliper above shows a measurement reading of **11.65mm**, this means that:

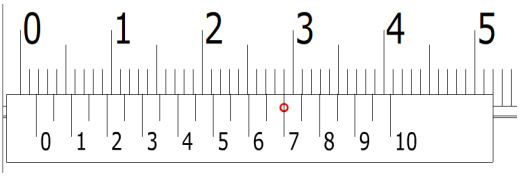
The **Main scale** contributes the main number. This number is taken from wherever the 0 on the Vernier Scale is. In this case you can see that the 0 on the Vernier Scale is just after the 11th millimeter mark, therefore it is **11.**

The **Vernier scale** contributes the two numbers after the decimal point. This number reading is taken from the first line on the Vernier scale to align perfectly with one of the lines on the main scale. In this case it is the line halfway between the 6 and 7, which gives us a reading of **.65**

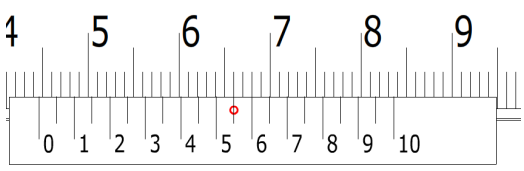


What reading do you get from this Vernier Caliper? 9.10mm _____

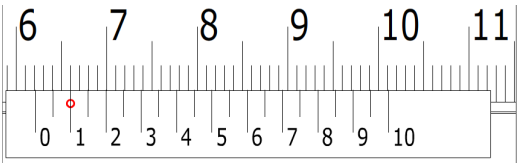
READING VERNIER CALIPERS



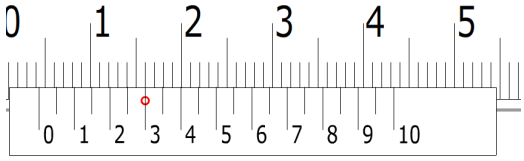
= 1.70mm



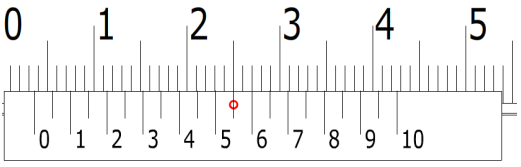
= 44.55mm



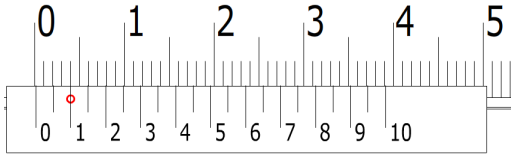
= 62.10mm



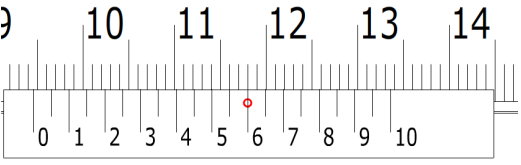
= 4.30mm



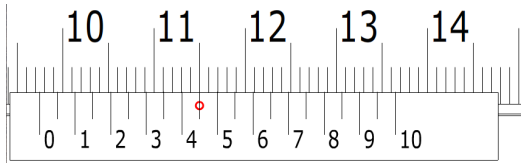
= 3.55mm



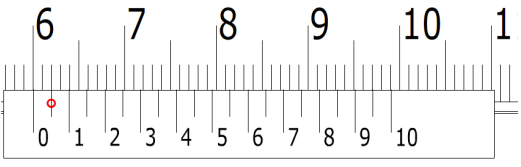
= 0.10mm



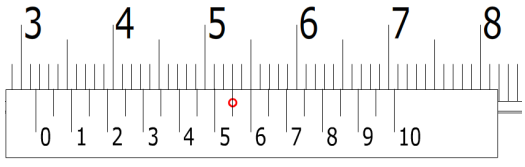
= 94.60mm



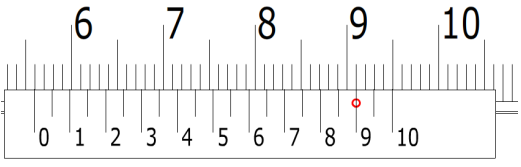
= 97.45mm



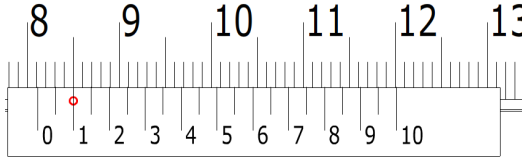
= 60.05mm



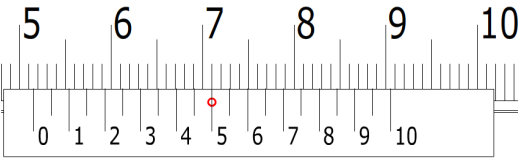
= 31.55mm



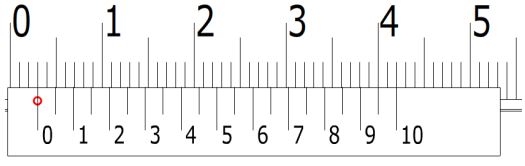
= 55.90mm



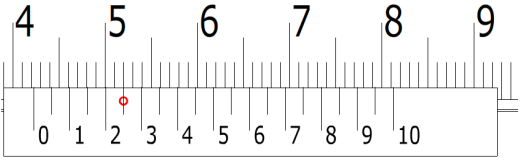
= 81.10mm



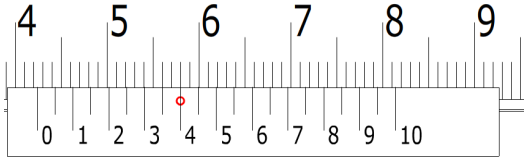
= 51.50mm



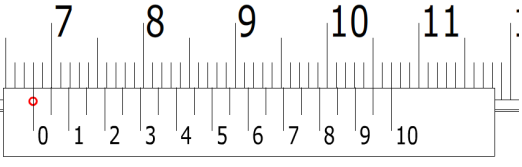
= 3.00mm



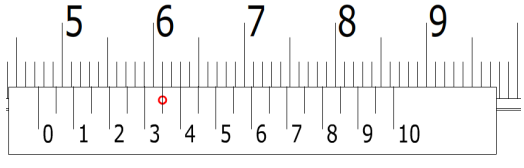
= 42.25mm



= 42.40mm

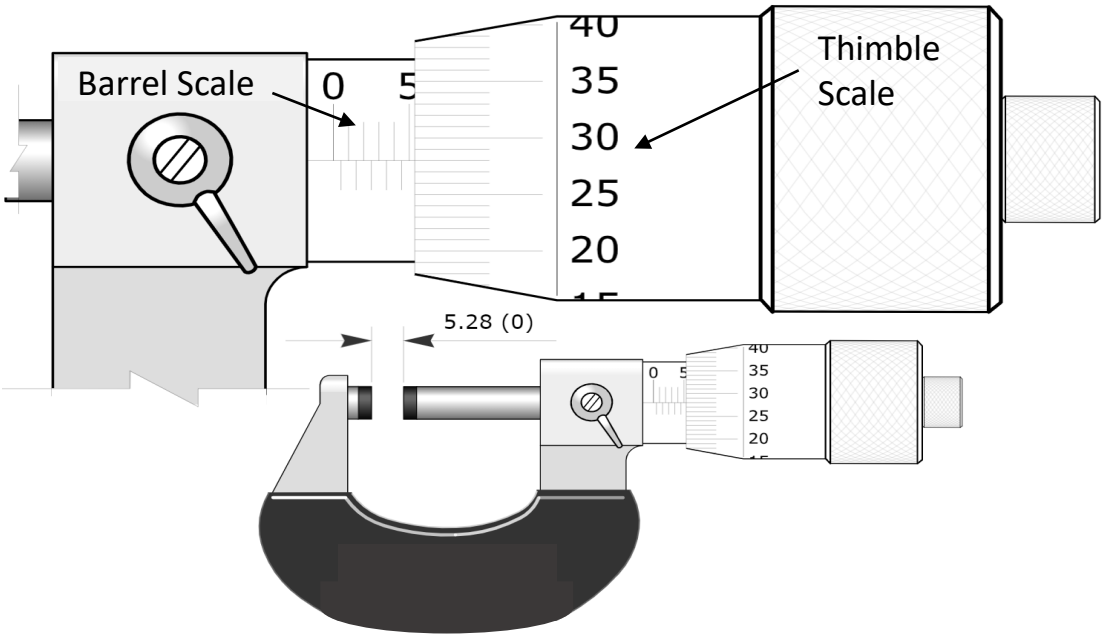


= 68.00mm



= 47.35mm

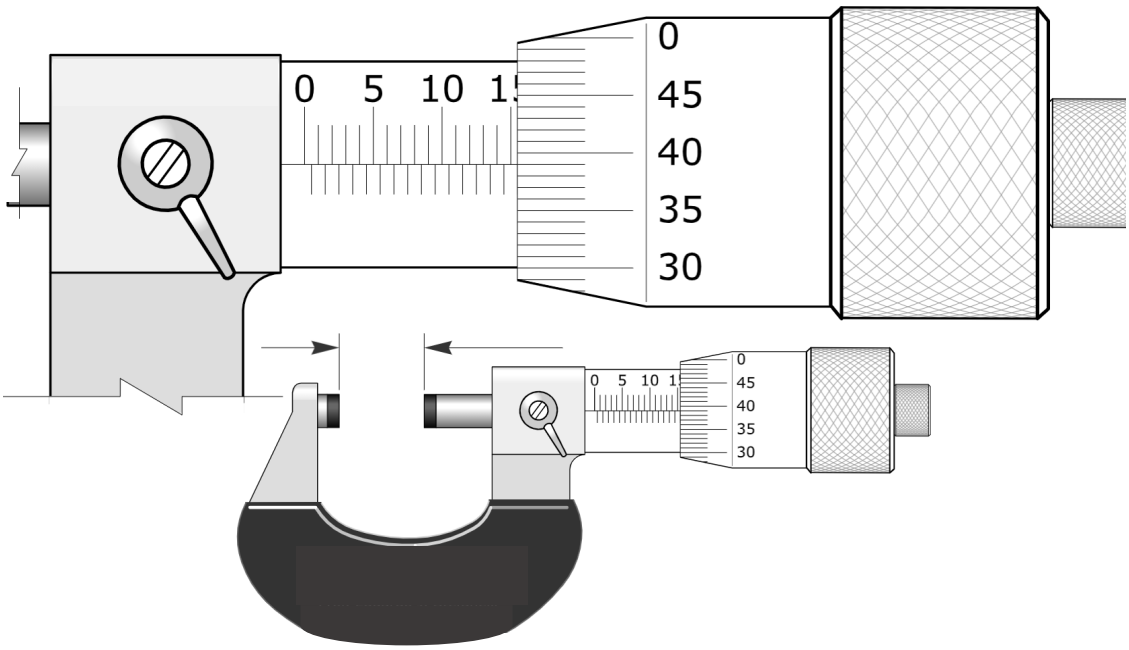
READING A MICROMETER



To understand the measurement readings from a Micrometer properly, you need to take two readings, first from the **Barrel Scale**, then from the **Thimble Scale**. For example, the Micrometer above shows a measurement reading of **5.28mm**, this means that:

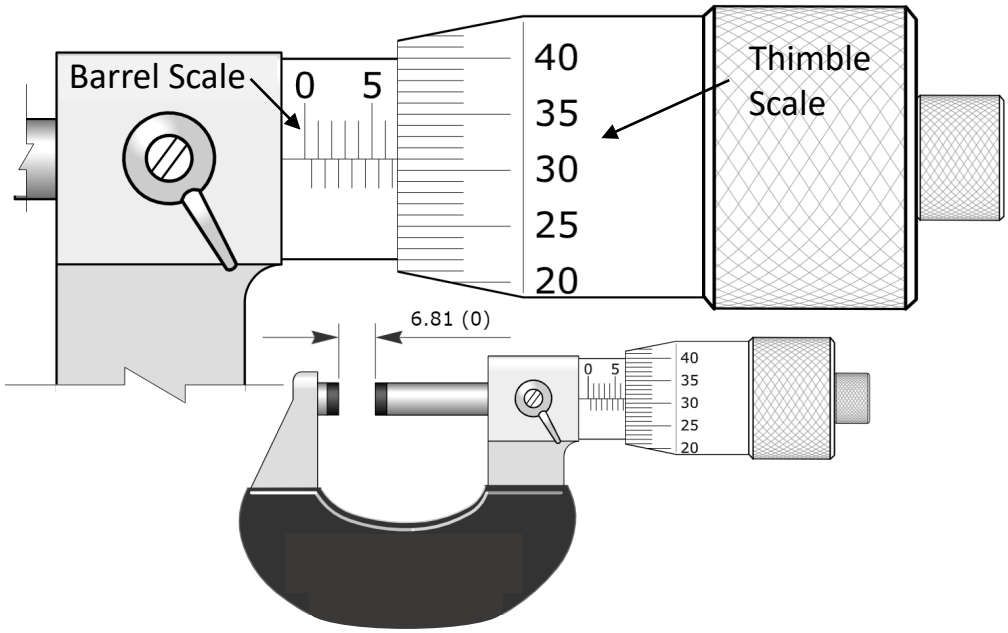
The **Barrel Scale** contributes the main number. This number is taken from the last visible graduation line on the Barrel Scale, above the horizontal line. In this case you can see that there is no visible line after the 5th millimeter mark, therefore it is **5.**

The **Thimble Scale** contributes the two numbers after the decimal point. This number reading is taken from the line on the Thimble Scale that aligns perfectly with the horizontal line on the Barrel Scale. In this case, it is the third line after the 25, which gives us a reading of **.28**



What reading do you get from this Micrometer? 15.39mm

READING A MICROMETER

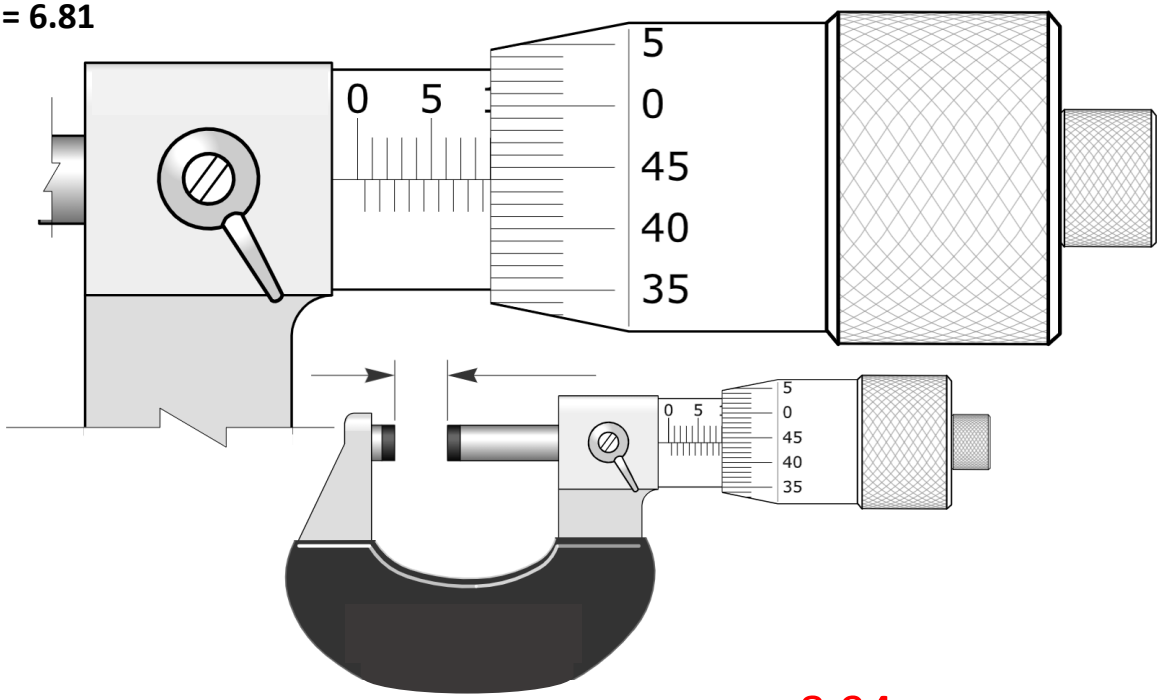


On a Micrometer, there are also lines below the horizontal line on the Barrel. These are not full millimeter marks. These are half millimeter marks. The lines above the horizontal line represent full millimeters, the ones below represent the half millimeter in-between them.

For example, there are 3 visible lines after the 5 millimeter mark on the barrel scale. This **does not** mean it is 8mm. This is showing the half millimeter mark after the 6mm mark, so it is **6.5mm**

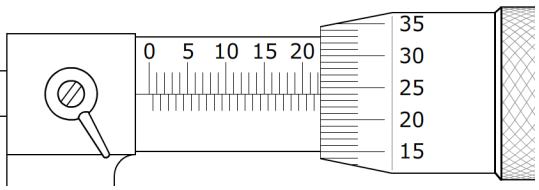
From this we need to add the reading from the Thimble Scale, which we can see is showing **.31**

6.5 + .31 **= 6.81**

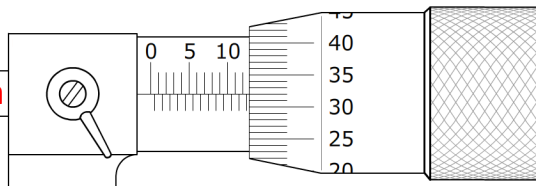


What reading do you get from this Micrometer? 8.94mm

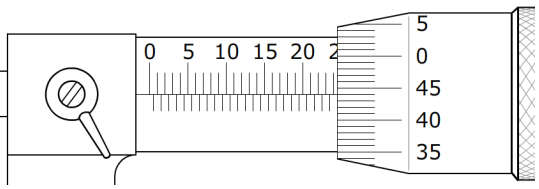
READING A MICROMETER



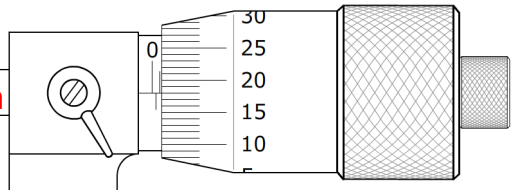
=22.24mm



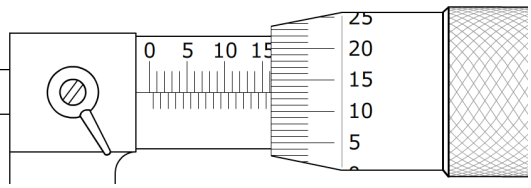
=12.82mm



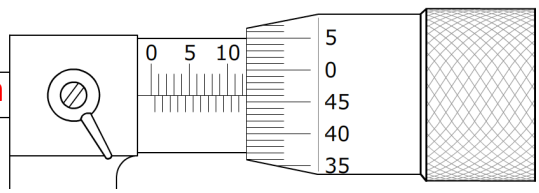
=24.44mm



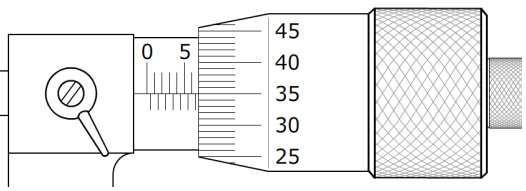
=1.18mm



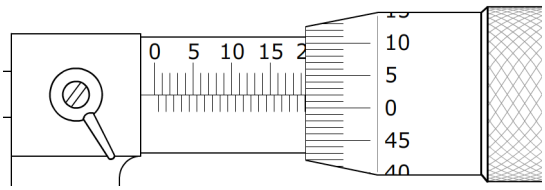
=16.13mm



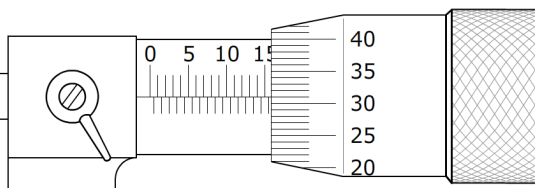
=12.46mm



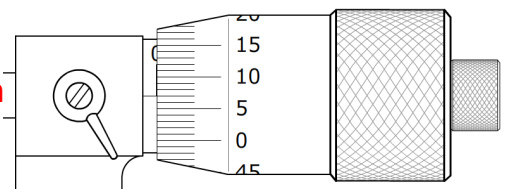
=6.85mm



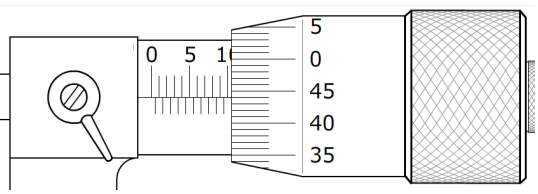
=19.52mm



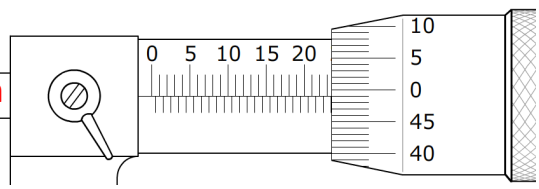
=16.81mm



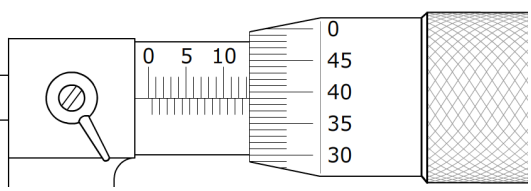
=0.07mm



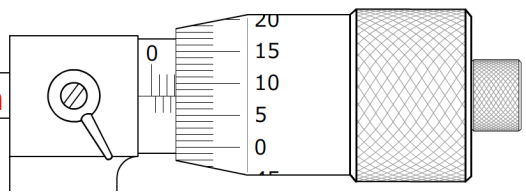
=10.44mm



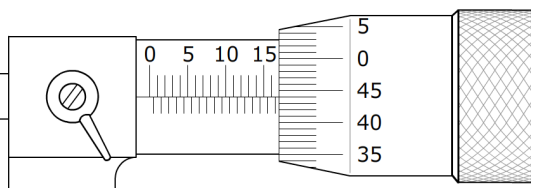
=23.49mm



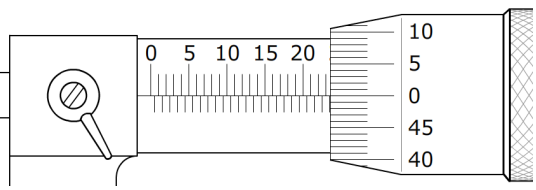
=13.39mm



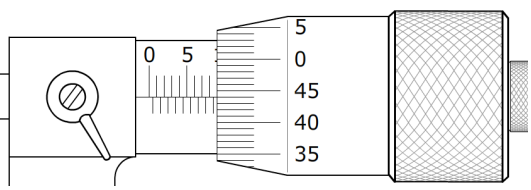
=3.08mm



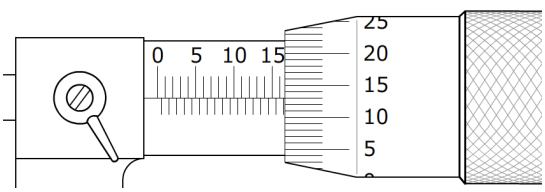
=16.94mm



=23.50mm



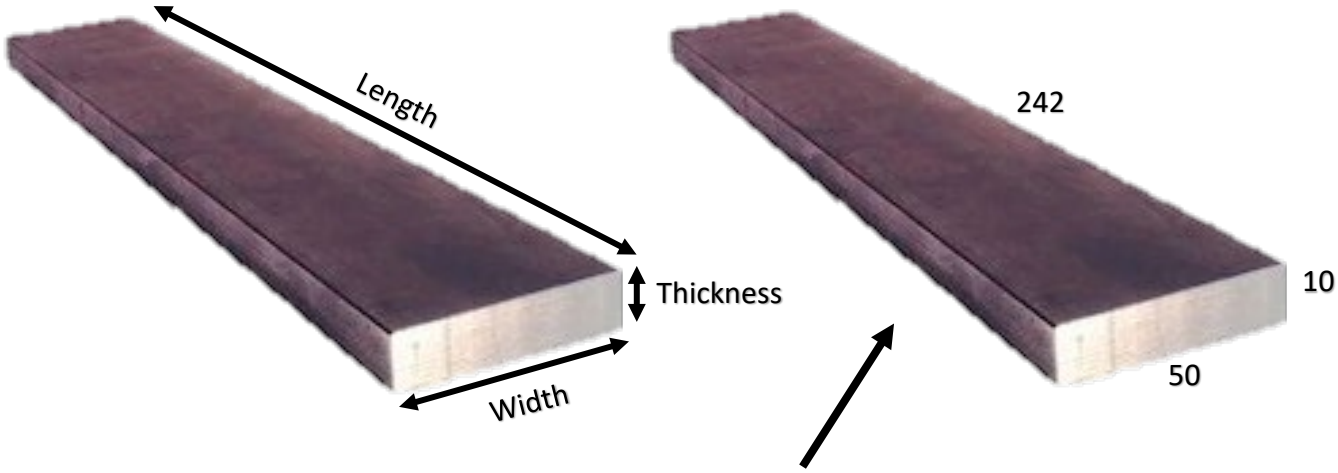
=8.94mm



=16.63mm

IDENTIFYING DIMENSIONS

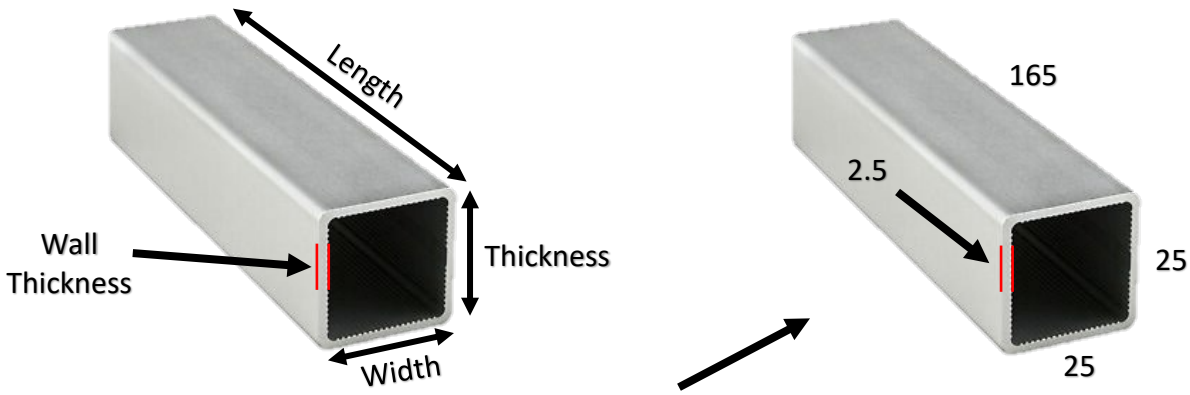
When identifying the dimensions of a piece of flat bar, first, look at the **cut edge**. This will give you your **Width** & **Thickness**. Once you have established them, measure away from this edge to get the **Length**.



See if you can Identify the dimensions of this piece!

Width	Thickness	Length
50mm	10mm	242mm

When identifying the dimensions of a piece of tubing, first, look at the cut edge. This will give you your **Width** & **Thickness**. Once you have established them, measure away from this edge to get the **Length**. When measuring tubing, its also important to measure the **Wall Thickness**, which is how thick the steel is that the tubing is made form. This is easily done with a Micrometer or a Vernier Calliper.

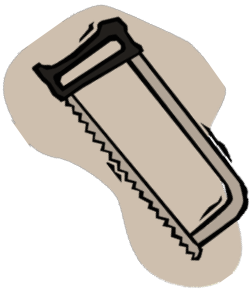


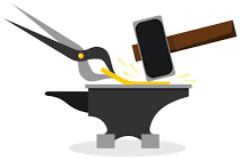
See if you can Identify the dimensions of this piece!

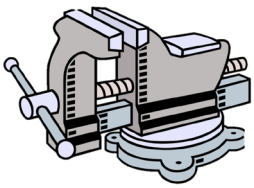
Width	Thickness	Length	Wall Thickness
25mm	25mm	165mm	2.5mm

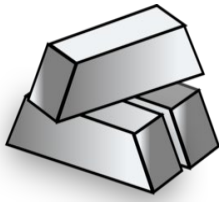
FLAT BAR MEASURMENT

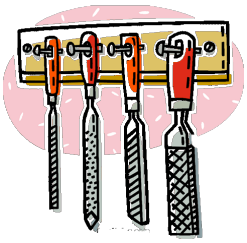
Piece	Width (mm)	Thickness (mm)	Length (mm)
A1	65	10	32.00
A2	65	10	50.10
A3	65	10	58.21
A4	50	10	28.05
A5	50	10	40.55
A6	50	10	60.95
A7	50	6	41.52
A8	50	6	51.20
A9	50	6	70.46
A10	25	15	30.66
A11	25	15	47.34
A12	25	15	65.18





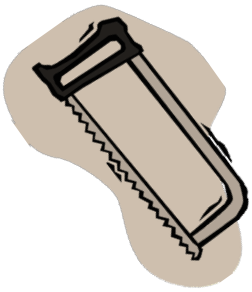


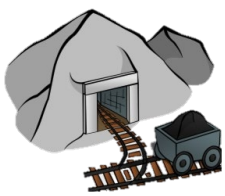


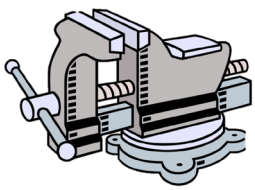


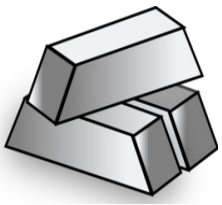
FLAT BAR MEASURMENT

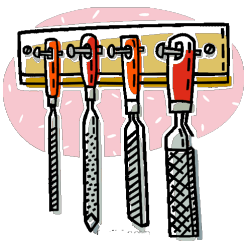
Piece	Width (mm)	Thickness (mm)	Length (mm)
A13	40	10	60.49
A14	40	10	49.70
A15	40	10	31.35
A16	32	5	29.53
A17	32	5	44.36
A18	32	5	59.14
A19	20	3	23.44
A20	20	3	53.83
A21	20	3	79.16
A22	25	3	32.74
A23	25	3	50.06
A24	25	3	72.72











FLAT BAR PRICES

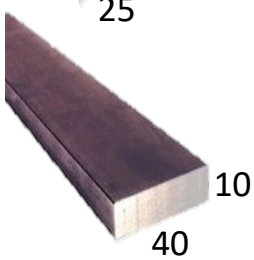
Below are the Lineal Metre prices (how much it costs to buy 1 metre) of common flat bar sizes found in the workshop.

$1.80

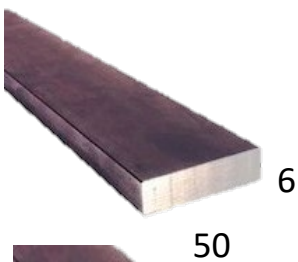
$2.25

$4.17

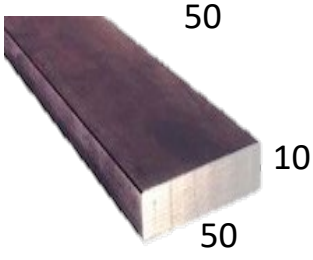
$5.42



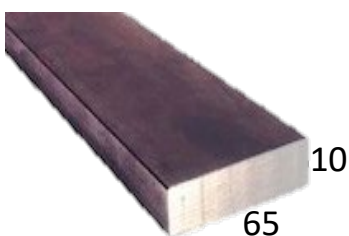
$10.00



$7.50



$12.50



$16.15

FLAT BAR PRICING ACTIVITY

To figure out the actual cost of the pieces you measured, you will have to:

1) Put the length of each piece in mm in the first column.
2) Convert the **Length** from mm to m. Which is easy! All you have to do is divide it by 1000! Put the answer in the second column.
3) Put in the lineal metre (L/m) price of each piece in the third column.
4) Multiply the length (m) by the lineal metre (L/m) price and put the answer in the fourth column.

Piece	Length (mm)	Length (m)	L/m Price	Actual Cost for Piece
A1	32.00 ÷ 1000	0.03200 X	$16.15 =	$0.52
A2	50.10	0.05010	$16.15	$0.81
A3	58.21	0.05821	$16.15	$0.94
A4	28.05	0.02805	$12.50	$0.35
A5	40.55	0.04055	$12.50	$0.51
A6	60.95	0.06095	$12.50	$0.76
A7	41.52	0.04152	$7.50	$0.31
A8	51.20	0.05120	$7.50	$0.38
A9	70.46	0.07046	$7.50	$0.53
A10	30.66	0.03066	$5.42	$0.17
A11	47.34	0.04734	$5.42	$0.26
A12	65.18	0.06518	$5.42	$0.35

FLAT BAR PRICING ACTIVITY

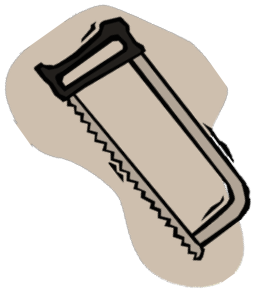
To figure out the actual cost of the pieces you measured, you will have to:

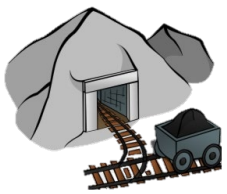
1) Put the length of each piece in mm in the first column.
2) Convert the **Length** from mm to m. Which is easy! All you have to do is divide it by 1000! Put the answer in the second column.
3) Put in the lineal metre (L/m) price of each piece in the third column.
4) Multiply the length (m) by the lineal metre (L/m) price and put the answer in the fourth column.

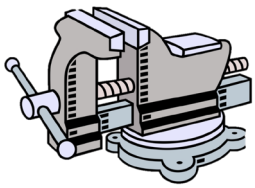
Piece	Length (mm)	Length (m)	L/m Price	Actual Cost for Piece
A13	60.49 ÷ 1000	0.06049 X	$10 =	$0.60
A14	49.70	0.04970	$10	$0.50
A15	31.35	0.03135	$10	$0.31
A16	29.53	0.02953	$4.17	$0.12
A17	44.36	0.04436	$4.17	$0.18
A18	59.14	0.05914	$4.17	$0.25
A19	23.44	0.02344	$1.80	$0.04
A20	53.83	0.05383	$1.80	$0.10
A21	79.16	0.07916	$1.80	$0.14
A22	32.74	0.03274	$2.25	$0.07
A23	50.06	0.05006	$2.25	$0.11
A24	72.72	0.07272	$2.25	$0.16

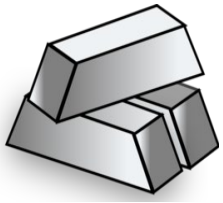
TUBING MEASURMENT

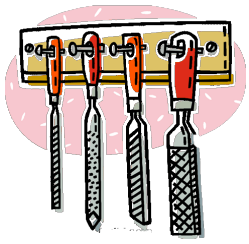
Piece	Width (mm)	Thickness (mm)	Length (mm)	Wall Thickness (mm)
B1	25	25	32.00	1.6
B2	25	25	57.57	1.6
B3	25	25	74.93	1.6
B4	50	25	72.32	3
B5	50	25	52.96	3
B6	50	25	121.80	3
B7	35	35	30.28	2
B8	35	35	54.19	2
B9	35	35	92.66	2





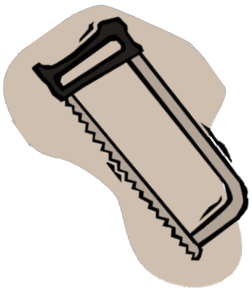


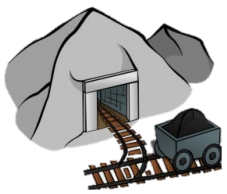


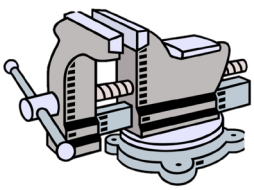


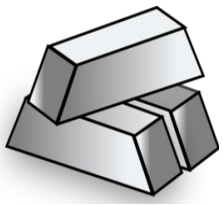
TUBING MEASURMENT

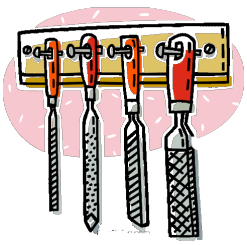
Piece	Width (mm)	Thickness (mm)	Length (mm)	Wall Thickness (mm)
B10	50	50	39.49	2
B11	50	50	50.20	2
B12	50	50	114.28	2
B13	40	40	43.40	2
B14	40	40	58.06	2
B15	40	40	113.82	2
B16	30	30	48.68	2
B17	30	30	59.25	2
B18	30	30	97.29	2







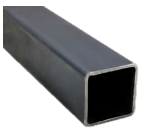




TUBING PRICES

Below are the Lineal Metre prices (how much it costs to buy 1 metre) of common Steel Tubing Sections found in the workshop.

Wall Thickness

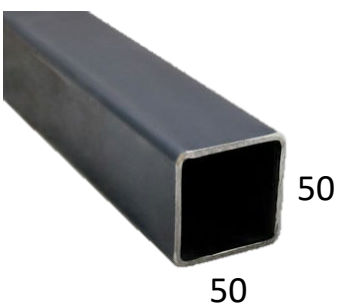


1.6mm → $4.40

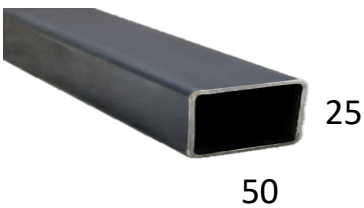
2mm → $6.20

2mm → $7.55

2mm → $8.80



2mm → $11.20



3mm → $11.00

TUBING PRICING ACTIVITY

To figure out the actual cost of the pieces you measured, you will have to:

1) Put the length of each piece in mm in the first column.
2) Convert the **Length** from mm to m. Which is easy! All you have to do is divide it by 1000! Put the answer in the second column.
3) Put in the lineal metre (L/m) price of each piece in the third column.
4) Multiply the length (m) by the lineal metre (L/m) price and put the answer in the fourth column.

Piece	Length (mm)	Length (m)	L/m Price	Actual Cost for Piece
B1	39.49 ÷ 1000	0.03249 X	$4.40 =	$0.14
B2	57.57	0.05757	$4.40	$0.25
B3	74.93	0.07493	$4.40	$0.33
B4	72.32	0.07232	$11	$0.80
B5	52.96	0.05296	$11	$0.58
B6	121.80	0.12180	$11	$1.34
B7	30.28	0.03028	$7.55	$0.22
B8	54.19	0.05419	$7.55	$0.41
b9	92.66	0.09266	$7.55	$0.70

TUBING PRICING ACTIVITY

To figure out the actual cost of the pieces you measured, you will have to:

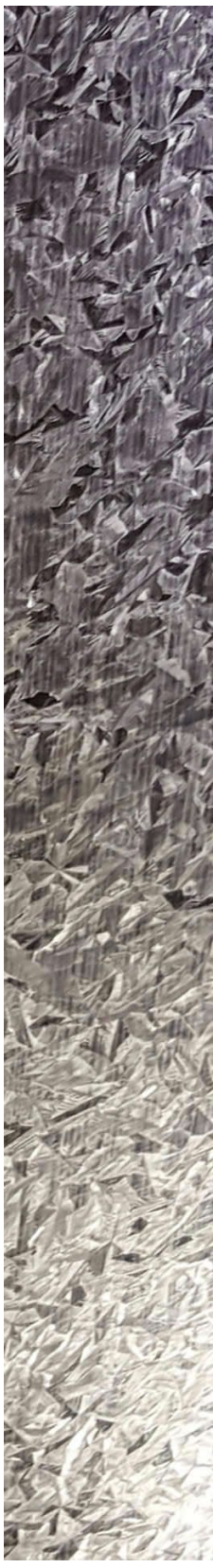
1) Put the length of each piece in mm in the first column.
2) Convert the **Length** from mm to m. Which is easy! All you have to do is divide it by 1000! Put the answer in the second column.
3) Put in the lineal metre (L/m) price of each piece in the third column.
4) Multiply the length (m) by the lineal metre (L/m) price and put the answer in the fourth column.

Piece	Length (mm)	Length (m)	L/m Price	Actual Cost for Piece
B10	39.49 ÷ 1000	0.03949 X	$11.20 =	$0.44
B11	50.20	0.05020	$11.20	$0.56
B12	114.28	0.11428	$11.20	$1.28
B13	43.40	0.04340	$8.80	$0.38
B14	58.06	0.05806	$8.80	$0.51
B15	113.82	0.11382	$8.80	$1
B16	48.68	0.04868	$6.20	$0.30
B17	59.25	0.05925	$6.20	$0.36
B18	97.29	0.09729	$6.20	$0.60

SHEET METAL MEASUREMENT

For this activity, you will first need to measure all the pieces of Sheet Metal in the box.

Piece	Length (mm)	Width (mm)	Thickness (mm)
1	93	109	0.6
2	100	280	0.6
3	101	186	0.6
4	92	112	0.8
5	88	141	0.8
6	92	163	0.8
7	128	256	1
8	92	205	1
9	205	217	1
10	37	109	1.2
11	106	108	1.2
12	109	158	1.2



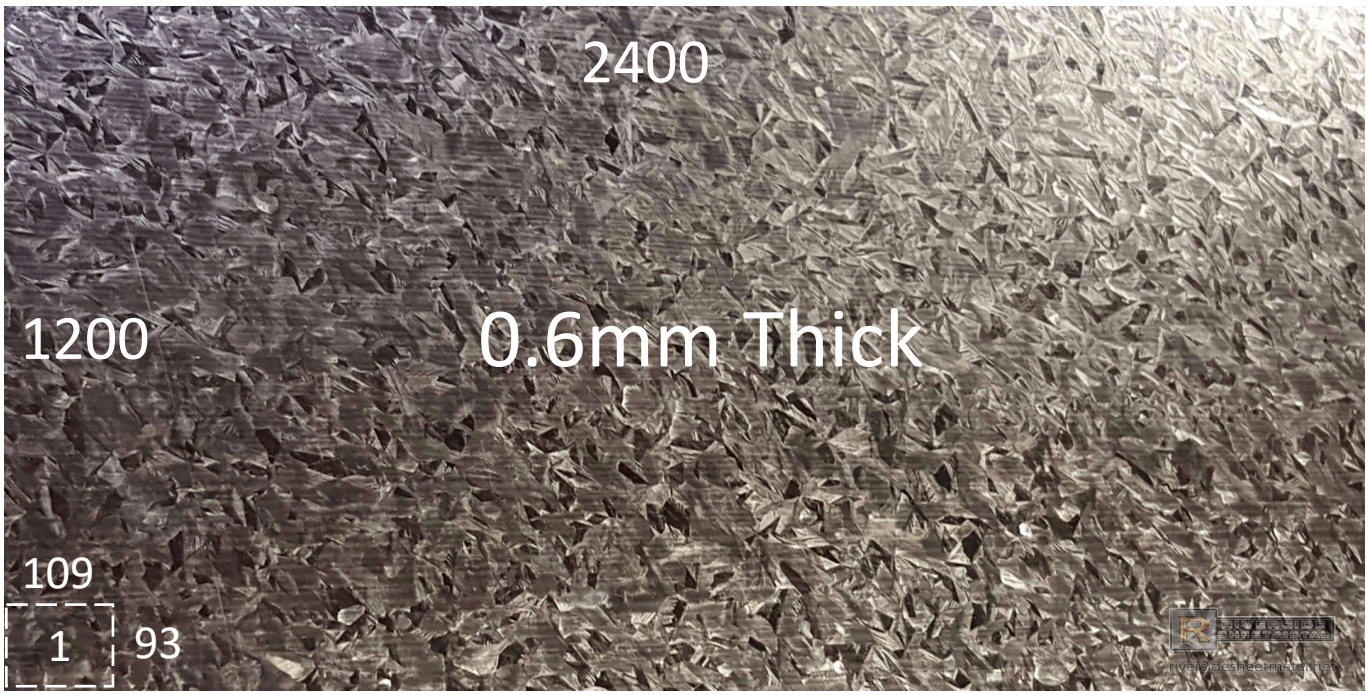
SHEET METAL COST

In the workshop we cant buy small pieces of Sheet Metal, we have to buy a big sheet and cut it up into smaller pieces. The sheets we buy are 2400mm x 1200mm and come in different thicknesses.

Thickness	Cost per Sheet
1.2mm	$110.12
1.0mm	$98.25
0.8mm	$81.73
0.6mm	$65.32

SHEET METAL COST

To figure out the actual cost of the small pieces of sheet metal you measured, you will have to:



$$\frac{\text{Area of Small Piece}}{\text{Area of Large Sheet}} \times \text{Cost of Sheet} = \text{Cost of Piece}$$

So to figure out the cost of Piece 1:

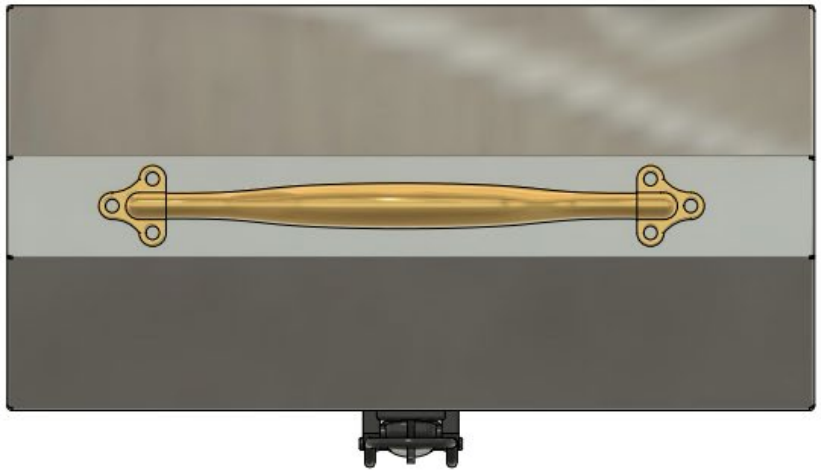
$$\frac{(109 \times 93)}{(2400 \times 1200)} \times \$65.32 = \mathbf{\$0.23}$$

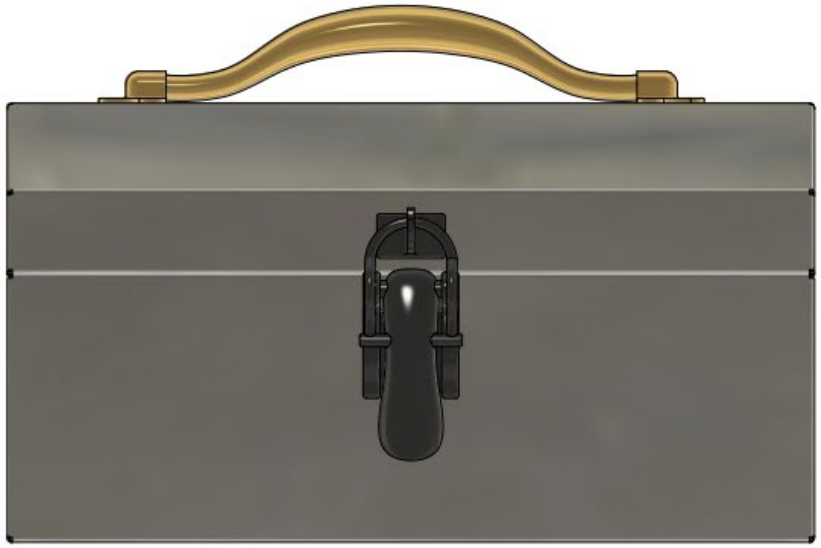
SHEET METAL COSTING

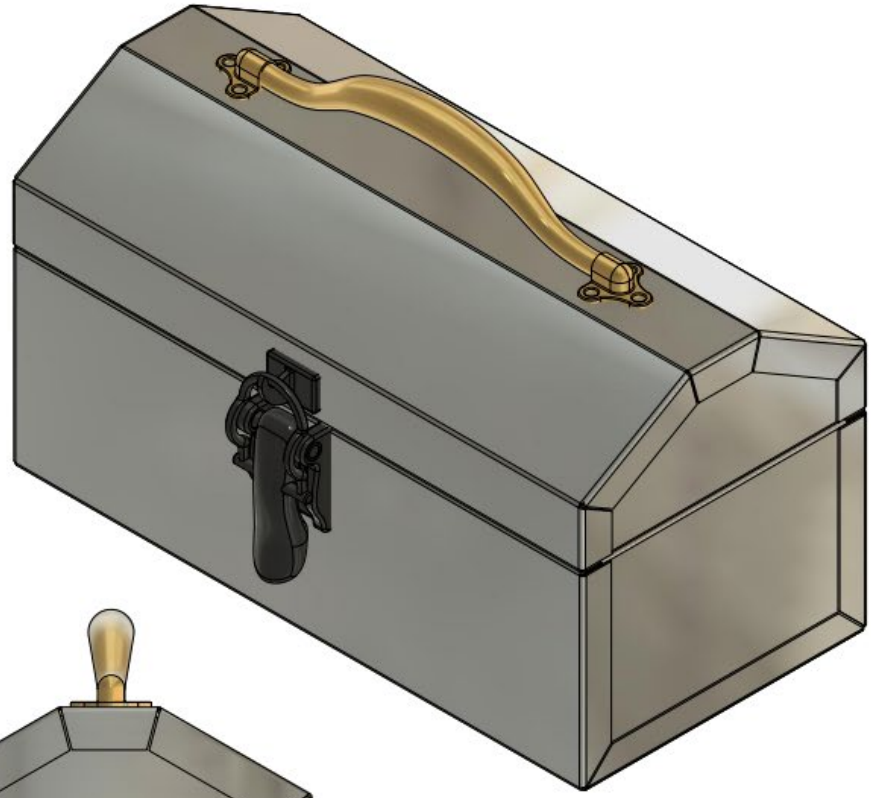
$$\frac{\text{Area of Small Piece}}{\text{Area of Large Sheet}} \times \text{Cost of Sheet} = \text{Cost of Piece}$$

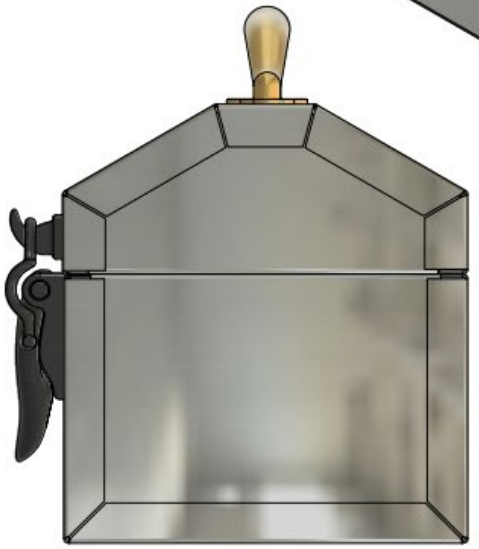
#	Working Out	#	Working Out
1	$\frac{(109 \times 93)}{(2400 \times 1200)} \times \$65.32 = \$0.23$	7	$\frac{(128 \times 256)}{(2400 \times 1200)} \times \$98.25 = \$1.12$
2	$\frac{(100 \times 280)}{(2400 \times 1200)} \times \$65.32 = \$0.64$	8	$\frac{(92 \times 205)}{(2400 \times 1200)} \times \$98.25 = \$0.64$
3	$\frac{(101 \times 186)}{(2400 \times 1200)} \times \$65.32 = \$0.43$	9	$\frac{(205 \times 217)}{(2400 \times 1200)} \times \$98.25 = \$1.52$
4	$\frac{(92 \times 112)}{(2400 \times 1200)} \times \$81.73 = \$0.29$	10	$\frac{(37 \times 109)}{(2400 \times 1200)} \times \$110.12 = \$0.15$
5	$\frac{(88 \times 141)}{(2400 \times 1200)} \times \$81.73 = \$0.35$	11	$\frac{(106 \times 108)}{(2400 \times 1200)} \times \$110.12 = \$0.44$
6	$\frac{(128 \times 256)}{(2400 \times 1200)} \times \$81.73 = \$0.93$	12	$\frac{(109 \times 158)}{(2400 \times 1200)} \times \$110.12 = \$0.66$

TOOLBOX COSTING



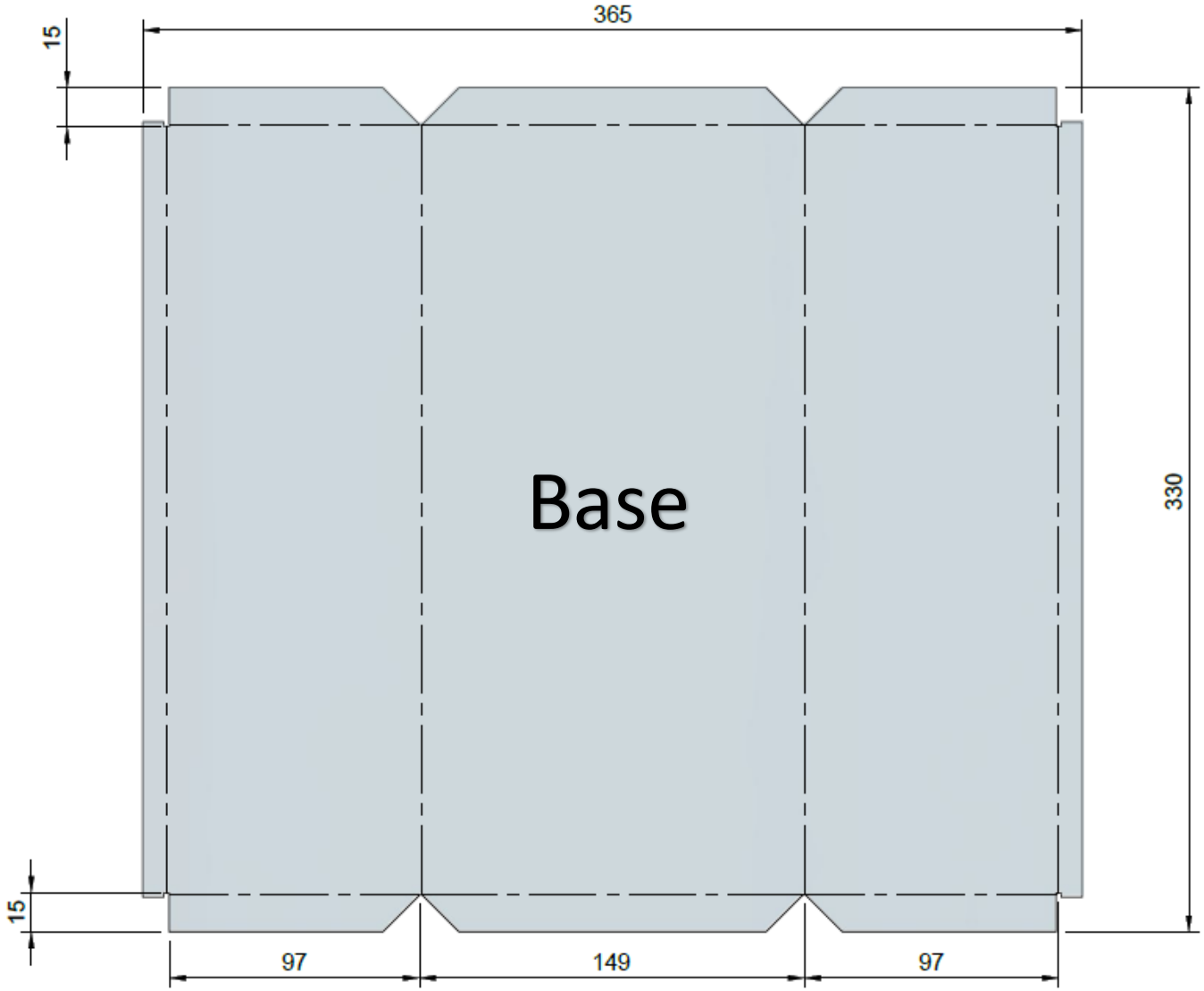


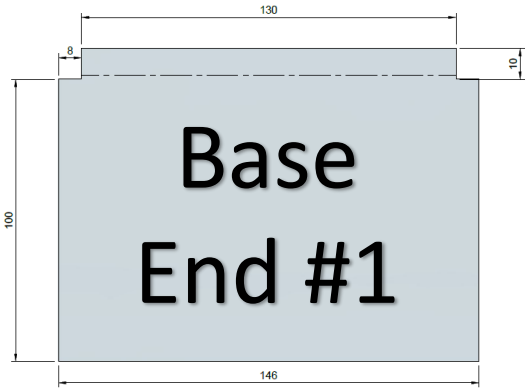


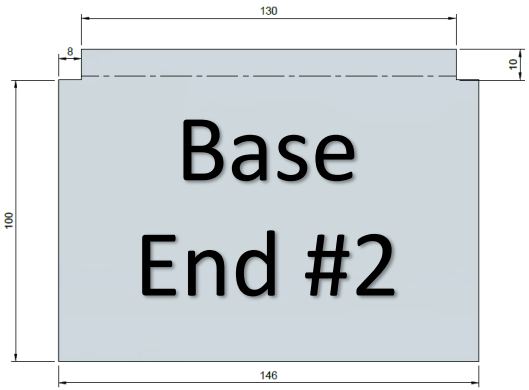


BASE PLANS

All parts made from
1.0mm Galvanized Sheet

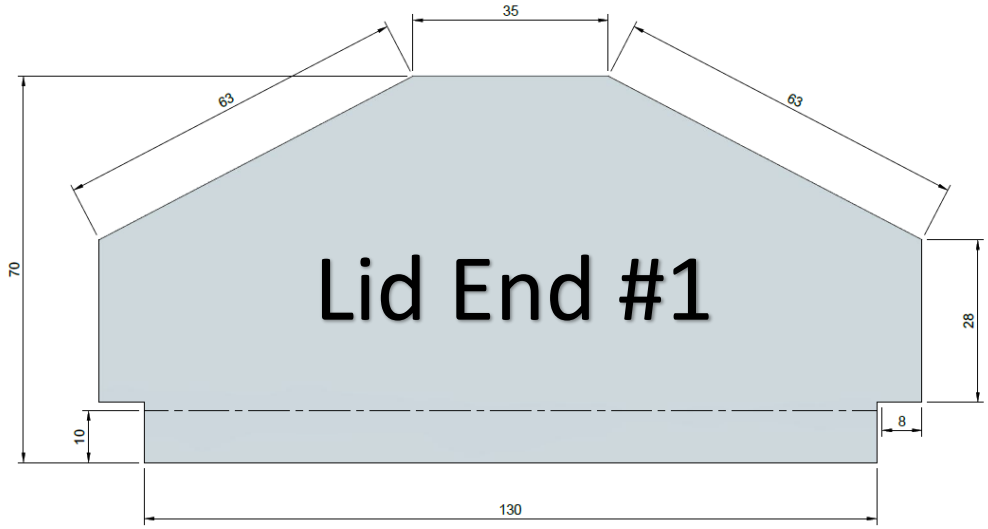




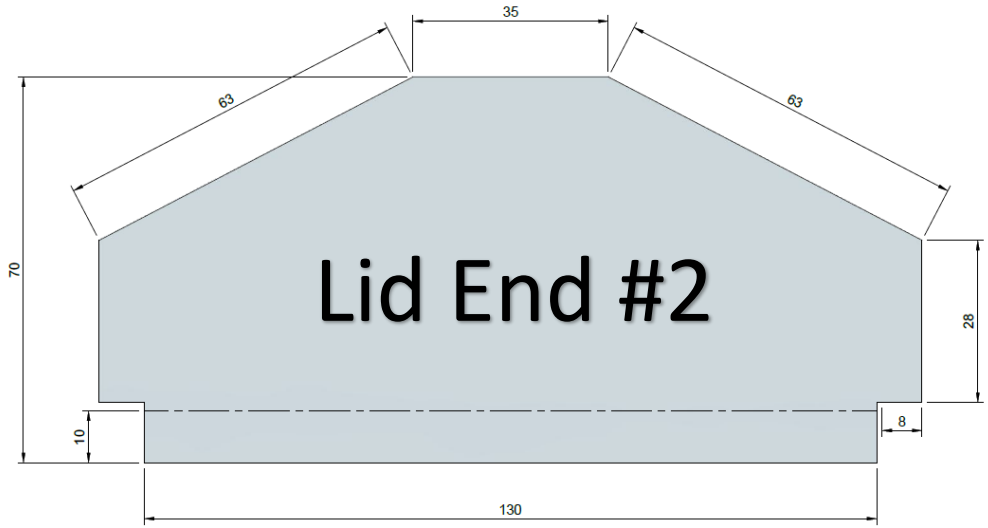


All parts made from
1.0mm Galvanized Sheet

LID PLANS



Lid End #1



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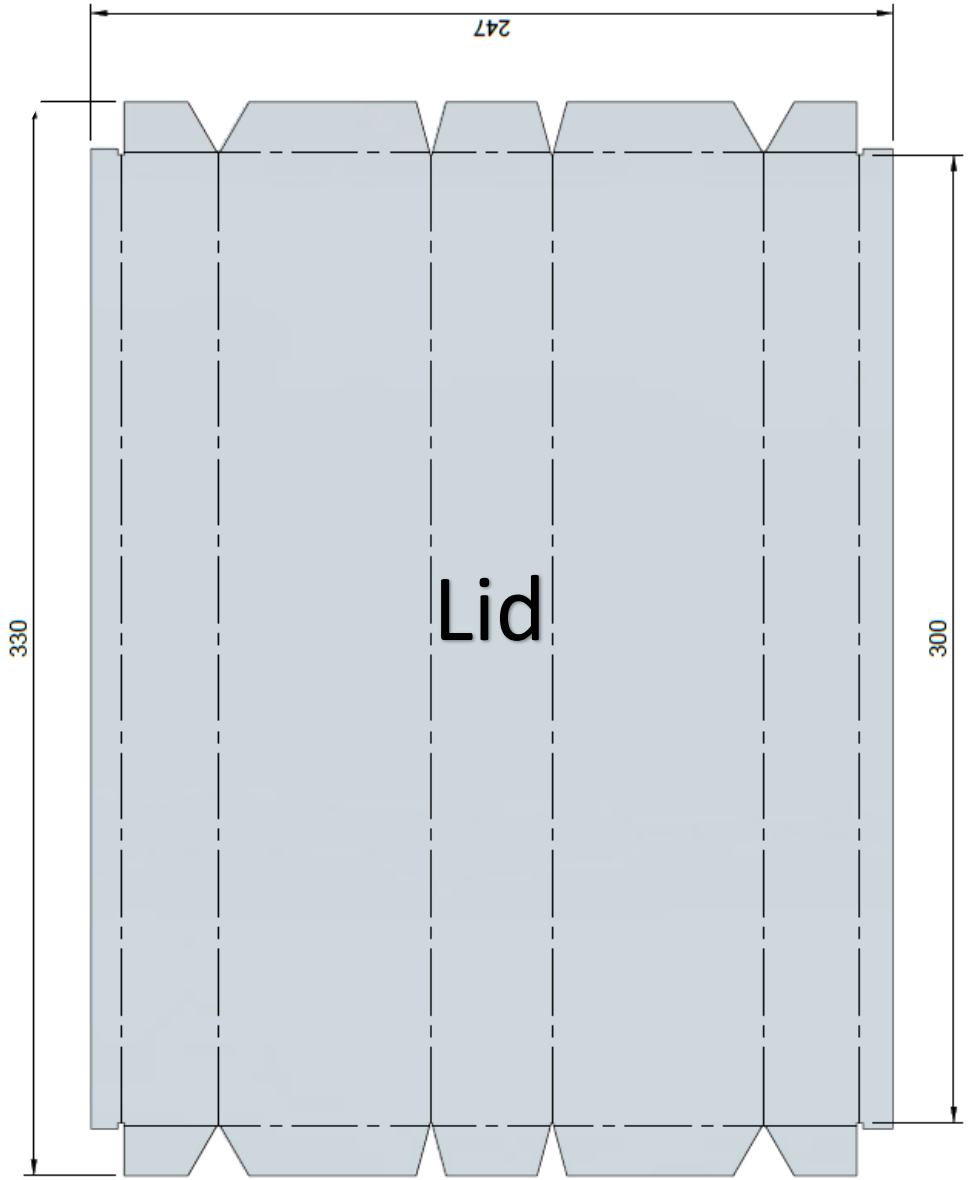

Lid

TOOLBOX COSTING

To figure out the cost of the Tool Box, first measure each piece:

Piece	Length (mm)	Width (mm)	Thickness (mm)
Base	365	330	1
Base End #1	146	110	1
Base End #2	146	110	1
Lid	330	247	1
Lid End #1	146	70	1
Lid End #2	146	70	1

Then calculate the cost of each piece:

Base $\frac{(365 \times 330)}{(2400 \times 1200)} \times \$98.25 = \$4.11$

Base End #1 $\frac{(146 \times 110)}{(2400 \times 1200)} \times \$98.25 = \$0.55$

Base End #2 $\frac{(146 \times 110)}{(2400 \times 1200)} \times \$98.25 = \$0.55$

Lid $\frac{(330 \times 247)}{(2400 \times 1200)} \times \$98.25 = \$2.78$

Lid End #1 $\frac{(146 \times 70)}{(2400 \times 1200)} \times \$98.25 = \$0.35$

Lid End #2 $\frac{(146 \times 70)}{(2400 \times 1200)} \times \$98.25 = \$0.35$

Then add together the cost for each piece and that will tell you how much the Tool Box will cost to make!

Total Cost: $8.69

WORKING OUT

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