Career Academy Teacher Externship Program

Career and Technical Education Multi-Unit Plan

Name: Michael P. O'Brien

District: Lena Public School District, Lena, WI

2017

Overview:

Measurement and common math are required to perform your job duties in nearly every aspect of conveyor manufacturing. I have compiled a list of skills relating to math and measurement that are essential for successful job performance. This include being able to:

- Read a tape measure accurately
- Add or subtract fractions
- Convert fractions to decimal form
- Use a decimal equivalent card or chart (drill gage)

Additional "shop math" lessons based on course the student is taking and their grade level may include:

- Board foot calculation
- Materials cost sheets (wood or metal projects)
- Measuring wood project materials to assure proper fit when assembled
- "Bend allowance" calculations in Metals Fab/Sheetmetal layout
- Measuring and layout exercises for various metal/sheetmetal projects
- Reading a Micromter/digital caliper. (Small engines, Metals 1 & 2)
- Ohm's Law calculations to find volts, amps, ohms, or watts. (Small engines, Electrathon)
- Measuring engine components for wear. (Small engines)
- Measuring lathe or mill projects. (Metals 1 & 2, Metals Fab, Electrathon)
- Measuring tubing, bar, or round stock for metals projects. (Metals 1 & 2, Metals Fab, Electrathon)
- Calculating bend angles for race car fabrication. (Electrathon)
- Calculating cost of producing projects for independent customers. (Materials, welding or fabrication supplies, potential profit/shop donation, etc.)
- Welding-Metals deposit rates

Featured Externship Business:
Nercon Corporation

Subject:
Measurement and Essential Shop Math

Grade Level:
6th thru 12th grades

Learning objectives:

After doing this activity, students should be able to:

- Read a tape measure accurately
- Add or subtract fractions
- Convert fractions to decimal form
- Use a decimal equivalent card or chart (drill gage)

Workplace Readiness Skill:

□ Social Skills
□ Teamwork
□ Attitude and Initiative
X Professionalism
X Communication
X Critical Thinking
X Planning and Organization
□ Media Etiquette

Type of Activity:

□ Individual
□ Small group
X Whole class

Wisconsin Standards for Technology and Engineering:

Content Area: MNF/Manufacturing:
Standard: MNF1: Students will be able to select and use manufacturing technologies.

MNF1.a: Identify, select and safely use tools, machines, products and systems for specific tasks.

MNF1.a.2.e: Recognize tools, machines and materials along with their applications and failures.

MNF1.a.3.e: Recognize the characteristics of length, volume, weight, area and time.

MNF1.a.5.m: Use tools, materials and machines safely to diagnose, adjust and repair systems.

MNF1.a.6.m: Explore both customary and metric systems of measurement and conversions.

MNF1.a.9.h: Select and apply the appropriate units and scales for situations involving measurement.

Content Area: AC/Architecture and Construction:
Standard: AC1: Students will be able to select and use architecture and construction technologies.

AC1.b: Apply measurement systems in the planning and layout process used in the residential construction industry.

AC1.b.3.e: Demonstrate scale and proportion (i.e. a toy car is a scale model of a full-sized car).

AC1.b.4.e: Demonstrate use of the Standard Measuring System to the 1/4” and the Metric Measuring System to centimeters.

AC1.b.5.e: Add, subtract, multiply and divide in the Standard Measuring System to the 1/4” and the Metric Measuring System to centimeters.

AC1.b.7.m: Calculate the required materials for simple structures.

AC1.b.8.m: Demonstrate basic dimensioning skills including the use of: dimension, extension, center and leader lines.
AC1.b.9.m: Demonstrate use of the Standard Measuring System to the 1/16" and the Metric Measuring System to millimeters.
AC1.b.10.m: Add, subtract, multiply and divide in the Standard Measuring System to the 1/16" and the Metric Measuring System to millimeters.
AC1.b.12.h: Calculate required materials for residential construction applications.
AC1.b.13.h: Convert scaled blueprint drawing measurements to full dimensions for a given construction project.
AC1.b.14.h: Apply conventional construction measurement processes accurately (i.e., geometric and trigonometric functions).
AC1.b.15.h: Use conventional construction formulas to determine production requirements.

Time:

Three periods of instruction, demonstration and student worktime. Additional "homework" time may be required by individual students. Additional exercises will be available for those students that need remedial work. These first three lessons are the basic math and measurement lessons, there are a number of additional "shop Math" related lessons depending on the course and grade level.

Materials:

- Tape measure/Ruler
- Starrett Decimal Equivalents Card
- Starrett Metric Equivalents Card
- Worksheet 1
- Worksheet 2
- Ruler reading sheets
- Various size boxes and brackets
- Helpful sites:
  - http://www.johnsonlevel.com/News/TapeMeasure
  - https://www.youtube.com/watch?v=2lEf92VPyYc
- Helpful reference resources:
  - Machinist's Ready Reference. Complied by C. Weingartner. Prakken Publications-Ann Arbor, MI ISBN:0-999968-50-8
  - www.Starrett.com - educational page has available order forms for a number of different starrett reference cards, etc. **Free in limited amounts to educators.**

Directions:

1. Students will complete a number of math and measurement lessons as part of a "shop Math" unit. Depending on grade level and the course they are in, there are many skill levels they can attain. The basic lessons all student must complete are:
   a. Fractions
   b. Decimals
   c. Reading a ruler/tape measure

2. After completion of the lecture and demonstrations of how to add and subtract fractions, students will complete Worksheet 2. I give a few examples (more if needed) of adding and subtracting. I also give a reminder of making sure to use common denominators to complete the problems and reduce to their lowest form. Upon completion of Worksheet 2 with 75% or better accuracy, we will move into ruler reading and measurement.

3. Students will watch the Youtube video (https://www.youtube.com/watch?v=2lEf92VPyYc) on reading a ruler and/or visit the Johnson level website (http://www.johnsonlevel.com/News/TapeMeasure). I draw the divisions of a ruler on the board. I demonstrate how to make inside and outside measurements with a tape measure. The students will then measure a variety of items in the classroom to get some experience making measurements. Examples: Table width, length, and height, door width and height. Students will then complete Worksheet 1 on reading a ruler. This worksheet must be completed with 100% accuracy. They may repeat the worksheet as needed until they attain 100%.

4. The third lesson of this unit is dealing with conversion--fraction to decimal or decimal to fraction. I lecture and give examples on the board of making the conversions. Examples: A blueprint shows me a dimension of 9 ¾ inches. If I divide the 4 (denominator) into the 3 (numerator) is will end up with the decimal equivalent of .75. Another example dimension of 3 3/8 inches. I divided the 8 into the 3 with the resulting decimal being .375. To do the opposite and convert from a decimal to fraction is really quite easy. A .75 inch can be converted to a fraction by multiplying .75 by the denominator you want in this case 4. (.75 x 4 = 3) so ¾ inch. The fraction for .625 inches is .625 x 8= 5 or 5/8th inch. The Starrett Equivalent Cards are essentially a reference chart you can use to compare fractions to decimals to metric sizes. Very useful and simple to use.

Wrap-up:

I have an oral quiz or review at the end of each lesson. The students read the Starrett Charts and see if they can answer my questions regarding equivalents. I randomly select students to complete the following problems on the board:

- A fraction problem on the board
- Convert a fraction to a decimal
- Convert a decimal to a fraction

I randomly select a few students to use a tape measures to measure items I have on hand.

Extension Activity:

I have a number of additional activities the students complete depending on grade level and the course they are enrolled in. The following are additional “Shop Math” or measuring activities:

- Board foot calculation

- Materials cost sheets (wood or metal projects)
- Measuring wood project materials to assure proper fit when assembled
- “Bend allowance” calculations in Metals Fab/Sheetmetal layout
- Measuring and layout exercises for various metal/sheetmetal projects
- Reading a Micromter/digital caliper. (Small engines, Metals 1 & 2)
- Ohm’s Law calculations to find volts, amps, ohms, or watts. (Small engines, Electrathon)
- Measuring engine components for wear
- Measuring lathe or mill projects
- Measuring tubing, bar, or round stock for metals projects
- Calculating bend angles for race car fabrication
- Calculating cost of producing projects for independent customers. (Materials, welding or fabrication supplies, potential profit/shop donation, etc.)

Starrett®

DECIMAL EQUIVALENTS

INCH/METRIC TAP DRILL SIZES & DECIMAL EQUIVALENTS

DRILL SIZE	DECIMAL EQUIV.	TAP SIZE
80	.0135	
79	.0145	
1/64	.0156	
78	.0160	
77	.0180	
76	.0200	
75	.0210	
74	.0225	
73	.0240	
72	.0250	
71	.0260	
70	.0280	
69	.0292	
68	.0310	
1/32	.0312	
67	.0320	
66	.0330	
65	.0350	
64	.0360	
63	.0370	
62	.0380	
61	.0390	
60	.0400	
59	.0410	
58	.0420	
57	.0430	
56	.0465	
3/64	.0469	0 - 80
55	.0520	
54	.0550	
53	.0595	1 -64, 72
1/16	.0625	
52	.0635	
51	.0670	
50	.0700	2 -56, 64
49	.0730	
48	.0760	
5/64	.0781	
47	.0785	3 - 48
46	.0810	
45	.0820	3 - 56
44	.0860	
43	.0890	4 - 40
42	.0935	4 - 48
3/32	.0938	
41	.0960	
40	.0980	
39	.0995	
38	.1015	5 - 40
37	.1040	5 - 44
36	.1065	6 - 32
7/64	.1094	
35	.1100	
34	.1110	
33	.1130	6 - 40
32	.1160	
31	.1200	
1/8	.1250	
30	.1285	
29	.1360	8 -32, 36
28	.1405	
9/64	.1406	
27	.1440	
26	.1470	
25	.1495	10 - 24
24	.1520	
23	.1540	
5/32	.1562	
22	.1570	
21	.1590	10 - 32
20	.1610	
19	.1660	
18	.1695	
11/64	.1719	
17	.1730	
16	.1770	12 - 24
15	.1800	
14	.1820	12 - 28
13	.1850	
3/16	.1875	
12	.1890	
11	.1910	
10	.1935	
9	.1960	
8	.1990	
7	.2010	1/4 - 20
13/64	.2031	
6	.2040	
5	.2055	
4	.2090	
3	.2130	1/4 - 28
7/32	.2188	
2	.2210	
1	.2280	
A	.2340	
15/64	.2344	
B	.2380	
C	.2420	
D	.2460	
1/4 E	.2500	
F	.2570	5/16 - 18
G	.2610	
17/64	.2656	
H	.2660	
I	.2720	5/16 - 24
J	.2770	
K	.2810	
9/32	.2812	
L	.2900	
M	.2950	
19/64	.2969	
N	.3020	
5/16	.3125	3/8 - 16
O	.3160	
P	.3230	
21/64	.3281	
Q	.3320	3/8 - 24
R	.3390	
11/32	.3438	
S	.3480	
T	.3580	
23/64	.3594	
U	.3680	7/16 - 14
3/8	.3750	
V	.3770	
W	.3860	
25/64	.3906	7/16 - 20
X	.3970	
Y	.4040	
13/32	.4062	
Z	.4130	
27/64	.4219	1/2 - 13
7/16	.4375	
29/64	.4531	1/2 - 20
15/32	.4688	
31/64	.4844	9/16 - 12
1/2	.5000	
33/64	.5156	9/16 - 18
17/32	.5312	5/8 - 11
35/64	.5469	
9/16	.5625	
37/64	.5781	5/8 - 18

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Starrett®

DECIMAL EQUIVALENTS

INCH/METRIC TAP DRILL SIZES & DECIMAL EQUIVALENTS

DRILL SIZE	DECIMAL EQUIVALENT	TAP SIZE
19/64	.5938	
39/64	.6094	
5/8	.6250	
41/64	.6406	
21/32	.6562	3/4 - 10
43/64	.6719	
11/16	.6875	3/4 - 16
45/64	.7031	
23/32	.7188	
47/64	.7344	
3/4	.7500	
49/64	.7656	7/8 - 9
25/32	.7812	
51/64	.7969	
13/16	.8125	7/8 - 14
53/64	.8281	
27/32	.8438	
55/64	.8594	
7/8	.8750	1 - 8
57/64	.8906	
29/32	.9062	
59/64	.9219	1 - 12
15/16	.9375	1 - 14
61/64	.9531	
31/32	.9688	
63/64	.9844	1 1/8 - 7
1	1.0000	
1 3/64	1.0469	1 1/8 - 12
1 7/64	1.1094	1 1/4 - 7
1 1/8	1.1250	
1 11/64	1.1719	1 1/4 - 12
1 7/32	1.2188	1 3/8 - 6
1 1/4	1.2500	
1 19/64	1.2969	1 3/8 - 12
1 11/32	1.3438	1 1/2 - 6
1 3/8	1.3750	
1 27/64	1.4219	1 1/2 - 12
1 1/2	1.5000	

PIPE THREAD SIZES (NPSC)

THREAD	DRILL	THREAD	DRILL
1/8 – 27	11/32	1 1/2 – 11 1/2	1 3/4
1/4 – 18	7/16	2 – 11 1/2	2 7/32
3/8 – 18	37/64	2 1/2 – 8	2 21/32
1/2 – 14	23/32	3 – 8	3 1/4
3/4 – 14	59/64	3 1/2 – 8	3 3/4
1 – 11 1/2	1 5/32	4 – 8	4 1/4
1 1/4 – 11 1/2	1 1/2		

METRIC TAP DRILL SIZES

METRIC TAP	TAP DRILL (mm)	DECIMAL (Inch)
M1.6 x 0.35	1.25	.0492
M1.8 x 0.35	1.45	.0571
M2 x 0.4	1.60	.0630
M2.2 x 0.45	1.75	.0689
M2.5 x 0.45	2.05	.0807
M3 x 0.5	2.50	.0984
M3.5 x 0.6	2.90	.1142
M4 x 0.7	3.30	.1299
M4.5 x 0.75	3.70	.1457
M5 x 0.8	4.20	.1654
M6 x 1	5.00	.1968
M7 x 1	6.00	.2362
M8 x 1.25	6.70	.2638
M8 x 1	7.00	.2756
M10 x 1.5	8.50	.3346
M10 x 1.25	8.70	.3425
M12 x 1.75	10.20	.4016
M12 x 1.25	10.80	.4252
M14 x 2	12.00	.4724
M14 x 1.5	12.50	.4921
M16 x 2	14.00	.5512
M16 x 1.5	14.50	.5709
M18 x 2.5	15.50	.6102
M18 x 1.5	16.50	.6496
M20 x 2.5	17.50	.6890
M20 x 1.5	18.50	.7283
M22 x 2.5	19.50	.7677
M22 x 1.5	20.50	.8071
M24 x 3	21.00	.8268
M24 x 2	22.00	.8661
M27 x 3	24.00	.9449
M27 x 2	25.00	.9843
M30 x 3.5	26.50	1.0433
M30 x 2	28.00	1.1024
M33 x 3.5	29.50	1.1614
M33 x 2	31.00	1.2205
M36 x 4	32.00	1.2598
M36 x 3	33.00	1.2992
M39 x 4	35.00	1.3780
M39 x 3	36.00	1.4173

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METRIC EQUIVALENTS

DECIMALS TO MILLIMETERS

DECIMAL	MM	DECIMAL	MM
.001	0.03	.470	11.94
.002	0.05	.480	12.19
.003	0.08	.490	12.45
.004	0.10	.500	12.70
.005	0.13	.510	12.95
.006	0.15	.520	13.21
.007	0.18	.530	13.46
.008	0.20	.540	13.72
.009	0.23	.550	13.97
.010	0.25	.560	14.22
.020	0.51	.570	14.48
.030	0.76	.580	14.73
.040	1.02	.590	14.99
.050	1.27	.600	15.24
.060	1.52	.610	15.49
.070	1.78	.620	15.75
.080	2.03	.630	16.00
.090	2.29	.640	16.26
.100	2.54	.650	16.51
.110	2.79	.660	16.76
.120	3.05	.670	17.02
.130	3.30	.680	17.27
.140	3.56	.690	17.53
.150	3.81	.700	17.78
.160	4.06	.710	18.03
.170	4.32	.720	18.29
.180	4.57	.730	18.54
.190	4.83	.740	18.80
.200	5.08	.750	19.05
.210	5.33	.760	19.30
.220	5.59	.770	19.56
.230	5.84	.780	19.81
.240	6.10	.790	20.07
.250	6.35	.800	20.32
.260	6.60	.810	20.57
.270	6.86	.820	20.83
.280	7.11	.830	21.08
.290	7.37	.840	21.34
.300	7.62	.850	21.59
.310	7.87	.860	21.84
.320	8.13	.870	22.10
.330	8.38	.880	22.35
.340	8.64	.890	22.61
.350	8.89	.900	22.86
.360	9.14	.910	23.11
.370	9.40	.920	23.37
.380	9.65	.930	23.62
.390	9.91	.940	23.88
.400	10.16	.950	24.13
.410	10.41	.960	24.38
.420	10.67	.970	24.64
.430	10.92	.980	24.89
.440	11.18	.990	25.15
.450	11.43	1.00	25.40
.460	11.68		

FRACTIONS TO DECIMALS TO MILLIMETERS

FRACTION	DECIMAL	MM	FRACTION	DECIMAL	MM
1/64	.0156	0.40	33/64	.5156	13.10
1/32	.0313	0.79	17/32	.5313	13.49
3/64	.0469	1.19	35/64	.5469	13.89
1/16	.0625	1.59	9/16	.5625	14.29
5/64	.0781	1.98	37/64	.5781	14.68
3/32	.0938	2.38	19/32	.5938	15.08
7/64	.1094	2.78	39/64	.6094	15.48
1/8	.1250	3.18	5/8	.6250	15.88
9/64	.1406	3.57	41/64	.6406	16.27
5/32	.1563	3.97	21/32	.6563	16.67
11/64	.1719	4.37	43/64	.6719	17.07
3/16	.1875	4.76	11/16	.6875	17.46
13/64	.2031	5.16	45/64	.7031	17.86
7/32	.2188	5.56	23/32	.7188	18.26
15/64	.2344	5.95	47/64	.7344	18.65
1/4	.2500	6.35	3/4	.7500	19.05
17/64	.2656	6.75	49/64	.7656	19.45
9/32	.2813	7.14	25/32	.7813	19.84
19/64	.2969	7.54	51/64	.7969	20.24
5/16	.3125	7.94	13/16	.8125	20.64
21/64	.3281	8.33	53/64	.8281	21.03
11/32	.3438	8.78	27/32	.8438	21.43
23/64	.3594	9.13	55/64	.8594	21.83
3/8	.3750	9.53	7/8	.8750	22.23
25/64	.3906	9.92	57/64	.8906	22.62
13/32	.4062	10.32	29/32	.9063	23.02
27/64	.4219	10.72	59/64	.9219	23.42
7/16	.4375	11.11	15/16	.9375	23.81
29/64	.4531	11.51	61/64	.9531	24.21
15/32	.4688	11.91	31/32	.9688	24.61
31/64	.4844	12.30	63/64	.9844	25.00
1/2	.5000	12.70	1	1.0000	25.40

Bulletin 1318 50M/S 06/09

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METRIC EQUIVALENTS

MILLIMETERS TO DECIMALS

MM	DECIMAL	MM	DECIMAL	MM	DECIMAL	MM	DECIMAL	MM	DECIMAL
0.01	.0004	0.41	.0161	0.81	.0319	21	.8268	61	2.4016
0.02	.0008	0.42	.0165	0.82	.0323	22	.8661	62	2.4409
0.03	.0012	0.43	.0169	0.83	.0327	23	.9055	63	2.4803
0.04	.0016	0.44	.0173	0.84	.0331	24	.9449	64	2.5197
0.05	.0020	0.45	.0177	0.85	.0335	25	.9843	65	2.5591
0.06	.0024	0.46	.0181	0.86	.0339	26	1.0236	66	2.5984
0.07	.0028	0.47	.0185	0.87	.0343	27	1.0630	67	2.6378
0.08	.0032	0.48	.0189	0.88	.0347	28	1.1024	68	2.6772
0.09	.0035	0.49	.0193	0.89	.0350	29	1.1417	69	2.7165
0.10	.0039	0.50	.0197	0.90	.0354	30	1.1811	70	2.7559
0.11	.0043	0.51	.0201	0.91	.0358	31	1.2205	71	2.7953
0.12	.0047	0.52	.0205	0.92	.0362	32	1.2598	72	2.8346
0.13	.0051	0.53	.0209	0.93	.0366	33	1.2992	73	2.8740
0.14	.0055	0.54	.0213	0.94	.0370	34	1.3386	74	2.9134
0.15	.0059	0.55	.0217	0.95	.0374	35	1.3780	75	2.9528
0.16	.0063	0.56	.0221	0.96	.0378	36	1.4173	76	2.9921
0.17	.0067	0.57	.0224	0.97	.0382	37	1.4567	77	3.0315
0.18	.0071	0.58	.0228	0.98	.0386	38	1.4961	78	3.0709
0.19	.0075	0.59	.0232	0.99	.0390	39	1.5354	79	3.1102
0.20	.0079	0.60	.0236	1.00	.0394	40	1.5748	80	3.1496
0.21	.0083	0.61	.0240	1	.0394	41	1.6142	81	3.1890
0.22	.0087	0.62	.0244	2	.0787	42	1.6535	82	3.2283
0.23	.0091	0.63	.0248	3	.1181	43	1.6929	83	3.2677
0.24	.0095	0.64	.0252	4	.1575	44	1.7323	84	3.3071
0.25	.0098	0.65	.0256	5	.1969	45	1.7717	85	3.3465
0.26	.0102	0.66	.0260	6	.2362	46	1.8110	86	3.3858
0.27	.0106	0.67	.0264	7	.2756	47	1.8504	87	3.4252
0.28	.0110	0.68	.0268	8	.3150	48	1.8898	88	3.4646
0.29	.0114	0.69	.0272	9	.3543	49	1.9291	89	3.5039
0.30	.0118	0.70	.0276	10	.3937	50	1.9685	90	3.5433
0.31	.0122	0.71	.0280	11	.4331	51	2.0079	91	3.5827
0.32	.0126	0.72	.0284	12	.4724	52	2.0472	92	3.6220
0.33	.0130	0.73	.0287	13	.5118	53	2.0866	93	3.6614
0.34	.0134	0.74	.0291	14	.5512	54	2.1260	94	3.7008
0.35	.0138	0.75	.0295	15	.5906	55	2.1654	95	3.7402
0.36	.0142	0.76	.0299	16	.6299	56	2.2047	96	3.7795
0.37	.0146	0.77	.0303	17	.6693	57	2.2441	97	3.8189
0.38	.0150	0.78	.0307	18	.7087	58	2.2835	98	3.8583
0.39	.0154	0.79	.0311	19	.7480	59	2.3228	99	3.8976
0.40	.0158	0.80	.0315	20	.7874	60	2.3622	100	3.9370

Worksheet 1

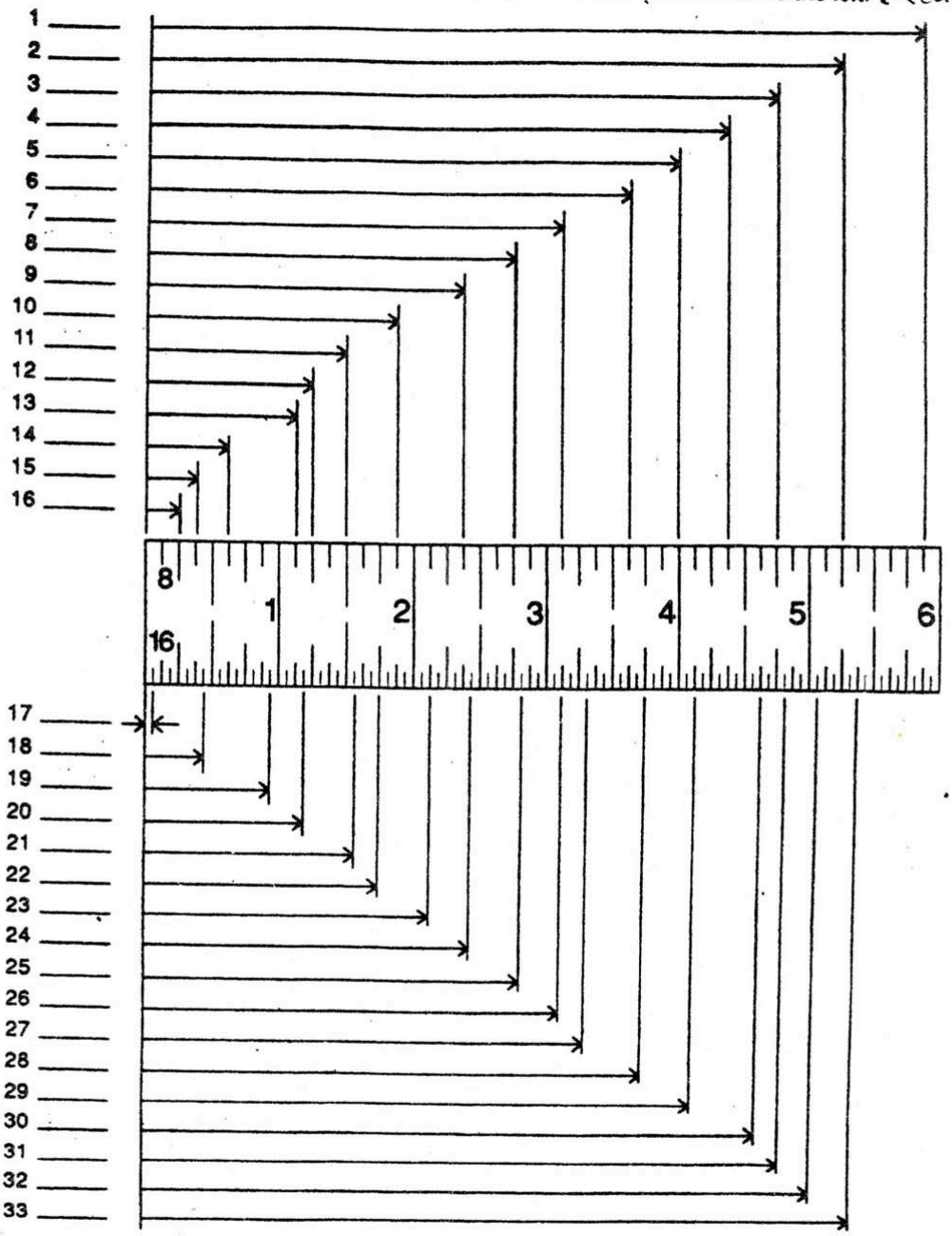
Pre-Measurement-Eval

_____ Hr. _____Qtr/Sem. **Name: _____**

Measurement Test

Name: _____ Date: _____

Write the correct measurement indicated by the arrows on the lines to the left. (Reduce)



Worksheet 2 **Pre-Measurement-Eval**

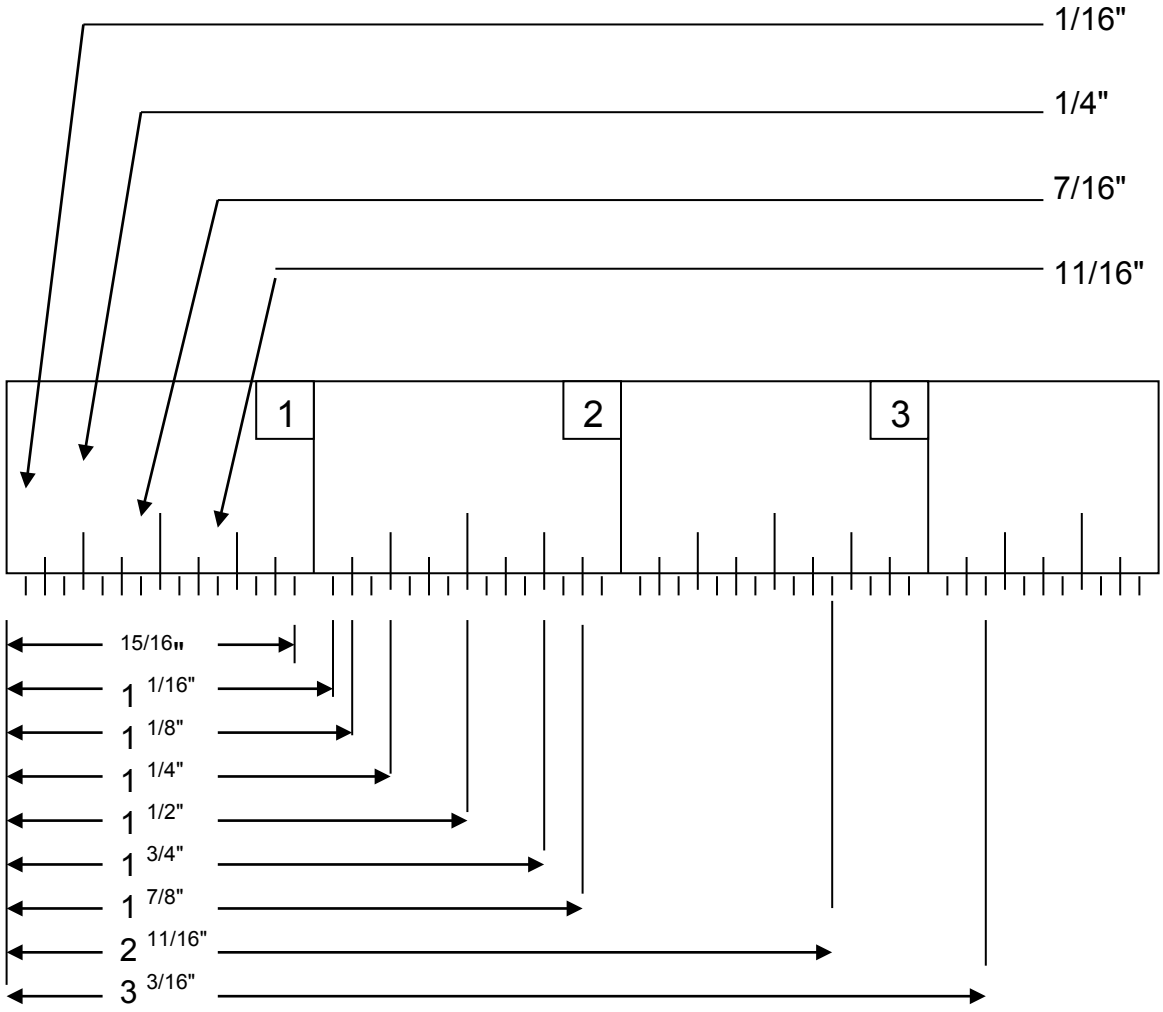
_____ Hr. _____Qtr/Sem. **Name: _____**

Directions: Solve the equations below in the space provided. **SHOW YOUR WORK** (1 pt each)

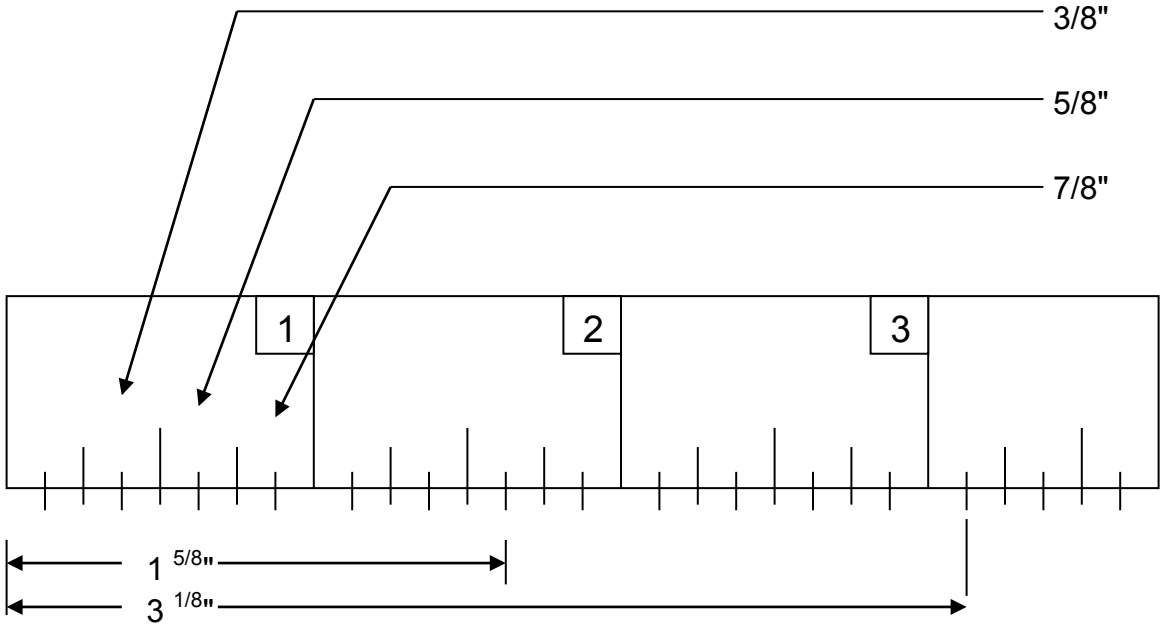
1. 1/2” + 1”=
2. 1/2” + 3/4”=
3. 3/8” + 7/8”=
4. 5/16” + 7/16”=
5. 3/16” + 3/4”=
6. 1/2” + 11/16”=
7. 11 1/2” + 3 1/2”=
8. 5 3/8” + 8 7/8”=
9. 10 3/16 + 6 1/4”=
10. 7 3/8” + 5 9/16”=
11. 1”-1/2”=
12. 3/4”-1/2”=
13. 7/8”-3/8”=
14. 7/16”-5/16”=
15. 3/4”- 3/16”=
16. 3/4”-11/16”=
17. 11 1/2”- 3 1/2”=
18. 8 7/8” – 5 3/8”
19. 10 3/16” – 6 1/4”=
20. 7 3/8”-5 9/16”=

MEASURING WITH A RULE/TAPE MEASURE

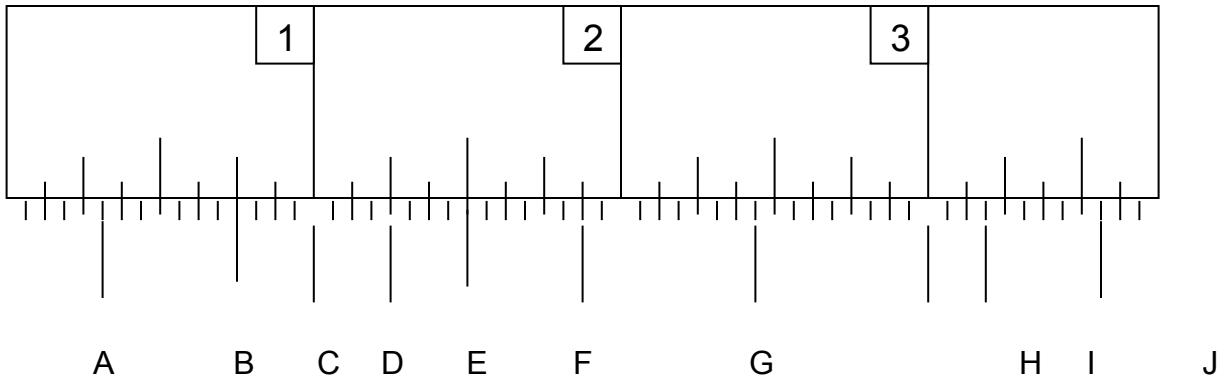
1/16th INCH SCALE

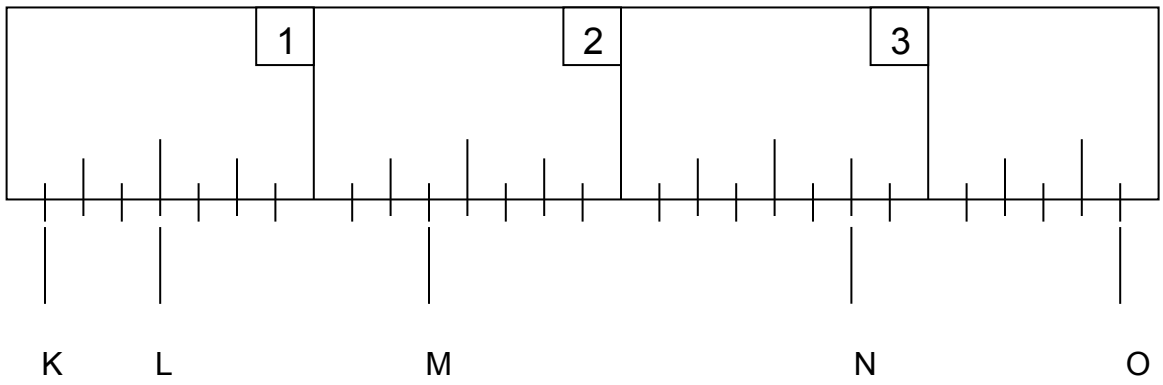


1/8th INCH SCALE



MEASURING WITH A RULE/TAPE MEASURE, WORKSHEET





Write down the measurements for the location at each letter.

1. A=_____
2. B=_____
3. C=_____
4. D=_____
5. E=_____
6. F=_____
7. G=_____
8. H=_____
9. I=_____
10. J=_____
11. K=_____
12. L=_____
13. M=_____
14. N=_____
15. O=_____

Measure lines 16 through 20 to the nearest 1/16th and record the results.

16. _____ 16=_____

17. _____ 17=_____

18. _____ 18=_____

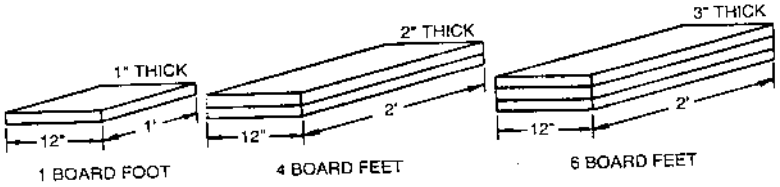
19. _____ 19=_____

20. _____ 20=_____

Additional Extension Activity Formulas/Worksheets

Board Feet

A board foot is defined as the equivalent of a piece of wood measuring one foot wide, one foot long and one inch thick. In each of the sketches, the number of board feet is shown.

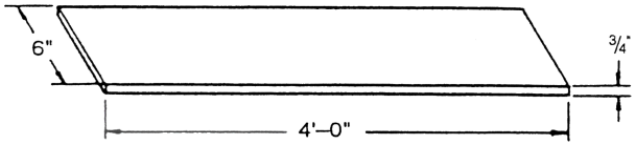


To calculate the board measure in any quantity or piece of lumber, use the formula

$$\text{Board feet} = T \times W \times L$$

in which T = thickness (expressed in inches), W = width (expressed in feet), and L = length (expressed in feet).

Example: To find the number of board feet in the piece of lumber shown, use T = 1 inch*, W = $\frac{6}{12}$ foot, and L = 4 feet.



Board feet = T x W x L = 1 x $\frac{6}{12}$ x 4 = 2 bd. ft.

*round to the next half unit higher

Notice thickness is always in inches and width and length are in feet.

Find the number of board feet in each of the following quantities:

1. 5 pieces of **1" x 6" x 18'**
2. 34 pieces of **2" x 4" x 16'**
3. 62 pieces of **1" x 10" x 18'**
4. 18 pieces of $\frac{1}{2}$**" x 4" x 16'**
5. 8 boards, $1\frac{1}{2}$**" thick, 22" wide, 16' long**
6. 25 pieces, $\frac{3}{4}$**" x 3" x 12'**

Various forumlas used in “Shop”.

Circles

π = 3.141592654 Diameter=width of a circle measured thru the center

Radius = ½ Diameter Circumference = Distance around a circle

Circumference = π D Diameter = C/π

Area of a circle

$A = \pi r^2$

Volume of a cylinder

$V = \pi r^2 \times \text{length}$

Rectangles

$A = L \times W$

$V = L \times W \times H$

Triangles

$A = \frac{1}{2} \times B \times H$

Pythagorean’s Theorem

$A^2 + B^2 = C^2$

Trigonometry

Sine=Opposite/Hypotenuse Cosine= Adjacent/Hypotenuse

Tangent=Opposite/Adjacent

Weight of Steels

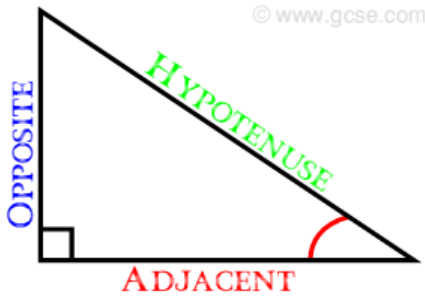
Aluminum = 0.098 Lbs/in^3 (6000 series)

Stainless Steel (300 series) = 0.283 Lbs/in^3

Carbon Steel= 0.283 Lbs/in^3

Conversion 1”= 25.4 mm

Angle	Sin	Cos	Tan	Angle	Sin	Cos	Tan
1	0.017	1.000	0.017	46	0.719	0.695	1.036
2	0.035	0.999	0.035	47	0.731	0.682	1.072
3	0.052	0.999	0.052	48	0.743	0.669	1.111
4	0.070	0.998	0.070	49	0.755	0.656	1.150
5	0.087	0.996	0.087	50	0.766	0.643	1.192
6	0.105	0.995	0.105	51	0.777	0.629	1.235
7	0.122	0.993	0.123	52	0.788	0.616	1.280
8	0.139	0.990	0.141	53	0.799	0.602	1.327
9	0.156	0.988	0.158	54	0.809	0.588	1.376
10	0.174	0.985	0.176	55	0.819	0.574	1.428
11	0.191	0.982	0.194	56	0.829	0.559	1.483
12	0.208	0.978	0.213	57	0.839	0.545	1.540
13	0.225	0.974	0.231	58	0.848	0.530	1.600
14	0.242	0.970	0.249	59	0.857	0.515	1.664
15	0.259	0.966	0.268	60	0.866	0.500	1.732
16	0.276	0.961	0.287	61	0.875	0.485	1.804
17	0.292	0.956	0.306	62	0.883	0.469	1.881
18	0.309	0.951	0.325	63	0.891	0.454	1.963
19	0.326	0.946	0.344	64	0.899	0.438	2.050
20	0.342	0.940	0.364	65	0.906	0.423	2.145
21	0.358	0.934	0.384	66	0.914	0.407	2.246
22	0.375	0.927	0.404	67	0.921	0.391	2.356
23	0.391	0.921	0.424	68	0.927	0.375	2.475
24	0.407	0.914	0.445	69	0.934	0.358	2.605
25	0.423	0.906	0.466	70	0.940	0.342	2.747
26	0.438	0.899	0.488	71	0.946	0.326	2.904
27	0.454	0.891	0.510	72	0.951	0.309	3.078
28	0.469	0.883	0.532	73	0.956	0.292	3.271
29	0.485	0.875	0.554	74	0.961	0.276	3.487
30	0.500	0.866	0.577	75	0.966	0.259	3.732
31	0.515	0.857	0.601	76	0.970	0.242	4.011
32	0.530	0.848	0.625	77	0.974	0.225	4.331
33	0.545	0.839	0.649	78	0.978	0.208	4.705
34	0.559	0.829	0.675	79	0.982	0.191	5.145
35	0.574	0.819	0.700	80	0.985	0.174	5.671
36	0.588	0.809	0.727	81	0.988	0.156	6.314
37	0.602	0.799	0.754	82	0.990	0.139	7.115
38	0.616	0.788	0.781	83	0.993	0.122	8.144
39	0.629	0.777	0.810	84	0.995	0.105	9.514
40	0.643	0.766	0.839	85	0.996	0.087	11.430
41	0.656	0.755	0.869	86	0.998	0.070	14.301
42	0.669	0.743	0.900	87	0.999	0.052	19.081
43	0.682	0.731	0.933	88	0.999	0.035	28.636
44	0.695	0.719	0.966	89	1.000	0.017	57.290
45	0.707	0.707	1.000	90	1.000	0.000	



Sine= O/H
Cosine= A/H
Tangent= O/A

LENGTHS OF CHORDS

Number of Divisions	Multiplier	Number of Divisions	Multiplier	Number of Divisions	Multiplier	Number of Divisions	Multiplier
3	.86603	28	.11197	53	.05924	77	.04079
4	.70711	29	.10812	54	.05815	78	.04027
5	.58779	30	.10453	55	.05709	79	.03976
6	.50000	31	.10117	56	.05607	80	.03926
7	.43388	32	.09802	57	.05509	81	.03878
8	.38268	33	.09506	58	.05414	82	.03830
9	.34202	34	.09227	59	.05322	83	.03784
10	.30902	35	.08964	60	.05234	84	.03739
11	.28173	36	.08716	61	.05148	85	.03695
12	.25882	37	.08480	62	.05065	86	.03652
13	.23932	38	.08258	63	.04985	87	.03610
14	.22252	39	.08047	64	.04907	88	.03569
15	.20791	40	.07846	65	.04831	89	.03529
16	.19509	41	.07655	66	.04758	90	.03490
17	.18375	42	.07473	67	.04687	91	.03452
18	.17365	43	.07300	68	.04618	92	.03414
19	.16460	44	.07134	69	.04552	93	.03377
20	.15643	45	.06976	70	.04487	94	.03342
21	.14904	46	.06824	71	.04423	95	.03306
22	.14232	47	.06679	72	.04362	96	.03272
23	.13617	48	.06540	73	.04302	97	.03238
24	.13053	49	.06407	74	.04244	98	.03205
25	.12533	50	.06279	75	.04188	99	.03173
26	.12054	51	.06156	76	.04133	100	.03141
27	.11609	52	.06038				

Multiplier x Diameter of Hole Circle= Chord Length

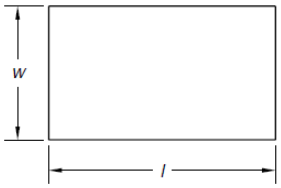
Example: If you were to lay out holes for a clock (12 holes or divisions) on a 12” circle with the holes set in ½”. We would have an 11” layout diameter. The multiplier for 12 divisions =0.25882

0.25882 x 11=2.847” between hole centers

AREA – PLANE FIGURES

$A = l \times w$

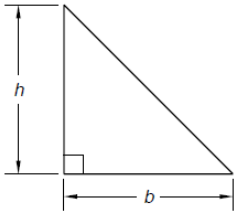
where
A = area
l = length
w = width



SQUARE OR RECTANGLE

$A = \frac{1}{2} \times b \times h$

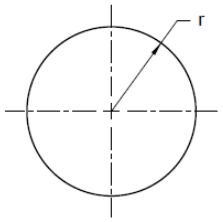
where
A = area
b = base
h = height



RIGHT TRIANGLE

$A = \pi r^2$

where
A = area
π = 3.1416
r = radius

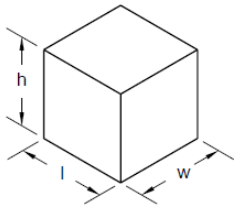


CIRCLE

VOLUME – SOLID FIGURES

$V = l \times w \times h$

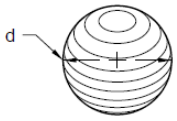
where
V = volume
l = length
w = width
h = height



RIGHT RECTANGULAR PRISM

$V = \frac{1}{6} \times \pi \times d^3$

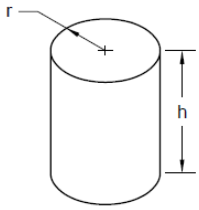
where
V = volume
π = 3.1416
d = diameter



SPHERE

$V = \pi r^2 \times h$

where
V = volume
π = 3.1416
r = radius
h = height



CYLINDER

DECIMAL EQUIVALENTS OF AN INCH

Fraction	Decimal	Fraction	Decimal	Fraction	Decimal	Fraction	Decimal
1/64	0.015625	17/64	0.265625	33/64	0.515625	49/64	0.765625
1/32	0.03125	9/32	0.28125	17/32	0.53125	25/32	0.78125
3/64	0.046875	19/64	0.296875	35/64	0.546875	51/64	0.796875
1/16	0.0625	5/16	0.3125	9/16	0.5625	13/16	0.8125
5/64	0.078125	21/64	0.328125	37/64	0.578125	53/64	0.828125
3/32	0.09375	11/32	0.34375	19/32	0.59375	27/32	0.84375
7/64	0.109375	23/64	0.359375	39/64	0.609375	55/64	0.859375
1/8	0.125	3/8	0.375	5/8	0.625	7/8	0.875
9/64	0.140625	25/64	0.390625	41/64	0.640625	57/64	0.890625
5/32	0.15625	13/32	0.40625	21/32	0.65625	29/32	0.90625
11/64	0.171875	27/64	0.421875	43/64	0.671875	59/64	0.921875
3/16	0.1875	7/16	0.4375	11/16	0.6875	15/16	0.9375
13/64	0.203125	29/64	0.453125	45/64	0.703125	61/64	0.953125
7/32	0.21875	15/32	0.46875	23/32	0.71875	31/32	0.96875
15/64	0.234375	31/64	0.484375	47/64	0.734375	63/64	0.984375
1/4	0.250	1/2	0.500	3/4	0.750	1	1.000

How to Calculate Cost of Wood

1. Find the area of the wood by multiplying width x length.
Note: You should round all fractional numbers up to the next whole number
Example:
W = 6"
L = 12"
Area = W x L
Area = 6” x 12”
Area = 72 square inches (sq. in.)

2. Convert that number into Board Feet (BF):
Formula:
BF = sq. in./144
BF = 72/144
BF = .5

3. Determine the cost of the piece of wood. Different species of wood have different costs. For this example, let’s say we are using a wood that costs $6.00 per board foot. Therefore the cost of this piece of wood would be:
Cost = price per BF x number of BF
Cost = $6.00 x .5
Cost = $3.00

So in this example, the first piece of wood would cost $3.00. You must repeat this step for each piece of wood, and add up the total to determine the cost of all the wood for your project.

Remember, for the projects that you are required to make in this class, the wood is provided for you, but if you make a mistake and ruin a piece of wood, you must pay for the piece to replace it!

Additional measuring reference material provided by Mr. Eric Strom. I give a copy of these worksheets to students that need additional review or remedial work. Something they can take with them and use as a study guide for measuring. Eric's work can be found on the Woodshop Teachers.org website: https://sites.google.com/a/woodshopteachers.org/www/lessonresources

Exploring Woodworking and Construction Technology

Course Syllabus

Fall semester 2009
Room T-3

Teacher: Mr. Storm (503) 386-1167 ex 1161
eric_storm@reynolds.k12.or.us

Measuring

History:

When woodworking, we do not use the Metric system, but instead use the Standard, or English system of measurement, meaning we measure in feet and inches, not in centimeters.

In the Standard system of measurement, inches are broken down in to fractions. In this class, we will use rulers which have each inch broken into 16 sections. Each of these sections is $^1/_{16}$ of an inch.

On this ruler, notice that each inch is broken into 16 parts. Also notice that only the inches are numbered. The lines that divide each inch are different lengths, but they are not numbered. If every line were numbered, the ruler would have way too many numbers on it, and would just get confusing.

People often ask why inches are broken into 16 sections, and not 10 or 14 or 19 or anything else. An inch is broken into 16 sections because that is what we end up with if we keep taking half of something.

Before accurate ways to measure and weigh things existed, this was a simple way to divide things into equal portions quite accurately.

Example:

Let's say you had a bucket of rice to sell at a market. If someone came up to you and said, "I would like to purchase $^1/_{10}$ of that rice, it would have been very difficult to measure out exactly that amount of rice without precise measuring devices.

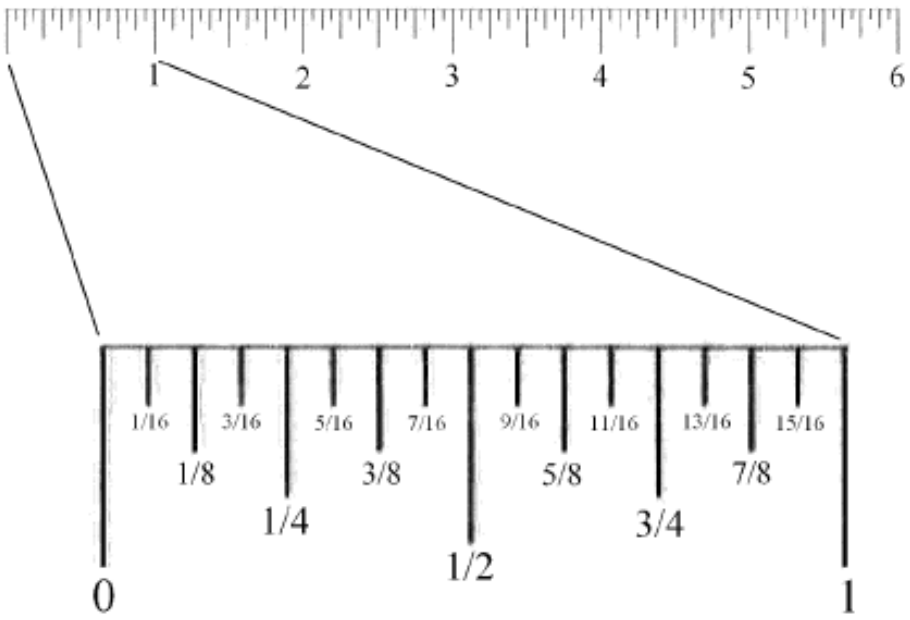
But if you had a simple balancing scale, you could very accurately divide the rice in half. You could then divide each half in half, ending up with $^1/_4$ of a bucket. You could then easily divide each $^1/_4$ in half to get exactly $^1/_8$ of a bucket of rice. By doing this, you could assure the person who was buying your rice that they were getting precisely $^1/_8$ a bucket of rice.

Another way to explain this is to talk about how pizzas are cut up, as shown in the following example.

How we measure, and how we write measurements:

Here is a ruler which is 6" long.

-Each inch is divided into 16 parts



Here is an enlarged picture of the first inch on a ruler.

-Each $^{1}/_{16}$" mark is labeled.

-All fractions are reduced.

If you count over from the beginning of the ruler 5 spaces, you will see that mark labeled as $^{5}/_{16}$". The next mark is not labeled as $^{6}/_{16}$", but is instead reduced down to $^{3}/_{8}$".

Use this page as a reference for the exercises on the following pages.

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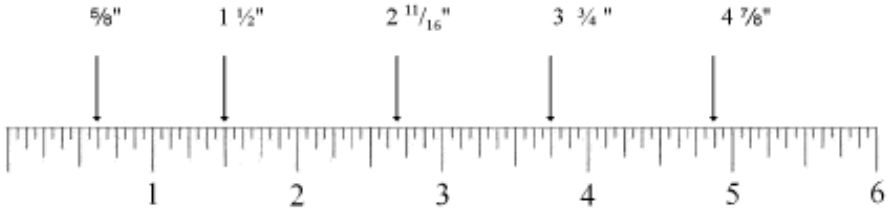


Notice how the 5 different measurements shown on this ruler are written:

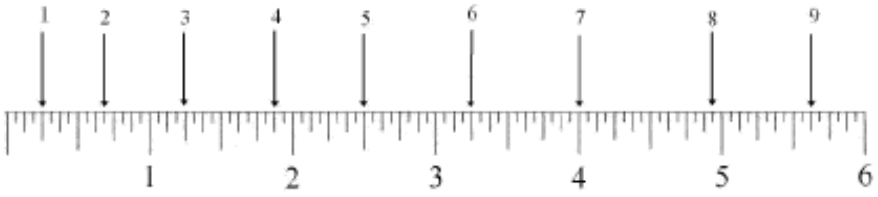
-The first one, 5/8", is 10 spaces over from the beginning of the ruler. It could be written as $^{10}/_{16}$", but we reduce that fraction to 5/8".

-The next one, 1 ½", is 8 spaces past the 1" mark. It could be written as 1 $^{8}/_{16}$", but we reduce it to 1 ½".

All of these measurements are written in the correct way. Use this page as a reference for the following worksheets.

Exercise 1

Correctly write the measurements for the following 9 locations.



1._____ 2._____ 3._____ 4._____ 5._____

6._____ 7._____ 8._____ 9._____

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Exercise 2

On this ruler, make and label an arrow for each of the following measurements.

$\frac{3}{8}$"	$\frac{3}{4}$"	$1\frac{1}{8}$"	$1\frac{9}{16}$"	$2\frac{5}{8}$"
$3\frac{3}{4}$"	$4\frac{1}{16}$"	$4\frac{13}{16}$"	$5\frac{5}{16}$"	6"

Exercise 3

On this ruler, make and label an arrow for each of the following measurements.

$\frac{5}{8}$"	$\frac{7}{8}$"	$1\frac{1}{4}$"	$1\frac{11}{16}$"	$2\frac{7}{8}$"
$3\frac{13}{16}$"	$4\frac{7}{16}$"	$4\frac{15}{16}$"	$5\frac{1}{2}$"	$5\frac{3}{4}$"

Exploring Woodworking and Construction Technology

Course Syllabus

Fall semester 2009
Room T-3

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