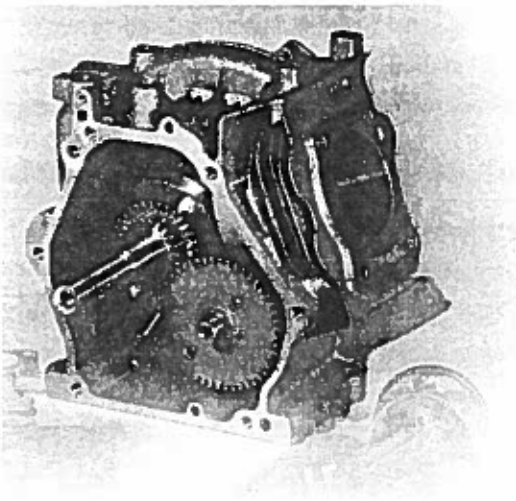


JOB 5

Measuring Instruments

Name _____ Date _____ Class _____

Introduction

Small gas engine technicians rely on measuring instruments to determine whether engine parts are worn beyond tolerable limits. Because parts vary in shape and size, the ability to measure with various kinds of instruments is very important. Engine manuals provide information about basic sizes and acceptable limits for each critical part of an engine. Dimensions may be given in US customary units or in metric units.

Objective

After successfully completing this job, you will be familiar with the measuring instruments needed to determine the condition of various engine parts.

Materials and Equipment

To complete this job, you will need the following materials and equipment:

- 12" ruler
- Telescoping gauge
- Small hole gauge
- Thickness gauge set
- US customary outside micrometer
- Metric outside micrometer
- Dial indicator with magnetic base
- Surface plate or other flat metal surface
- Thread pitch gauge set
- Torque wrench with 3/4" socket
- Machinist's vise with soft jaw covers
- .50-13 UNC × 2 hex head bolt
- Various sample objects provided by the instructor

Instructions

Before attempting this job, read Chapter 2, *Tools and Measuring Instruments* in the ***Small Gas Engines*** textbook.

After you read the job procedures, perform the tasks and answer all questions. As you complete each numbered step, place a check mark in the corresponding box. This will help you keep track of your progress. When you finish the job, ask your instructor to inspect your work and initial your completed job sheet.

Warning

Before performing this job, review all pertinent safety information in the text and discuss safety procedures with your instructor.

Procedures

1. Use a ruler to measure each of the following lines. Write your answer, in fractions of an inch, in the blank next to each line. Round your answers to the nearest 1/16". If you need help getting started, ask your instructor for assistance.

   ____ A.

   ____ B.

   ____ C.

   ____ D.

   ____ E.

   ____ F.

   ____ G.

   ____ H.

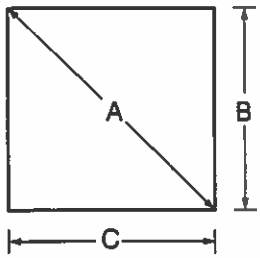
   ____ I.

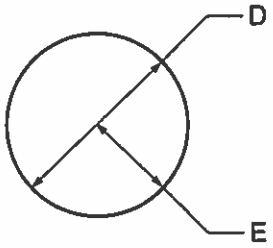
   ____ J.

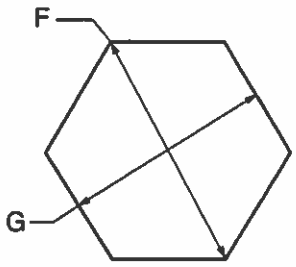
Completed ❑

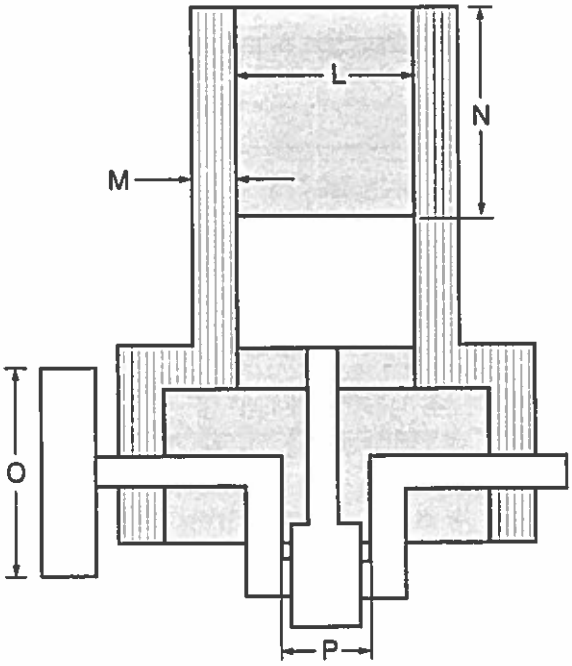
Name _____

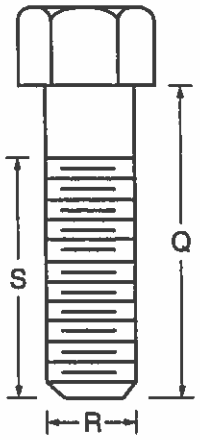
2. Measure the following parts drawings with your ruler. Record your answers, in fractions of an inch, on the lines provided. Measure the parts, not the dimension lines. Round to the nearest 1/16". Be sure to include the units of measure in your answers.











A. Diagonal = _____

B. Height = _____

C. Width = _____

D. Circle diameter = _____

E. Circle radius = _____

F. Bolt head point-to-point = _____

G. Across the flats of bolt head = _____

H. Valve stem diameter = _____

I. Valve stem length = _____

J. Valve margin = _____

K. Valve head size = _____

L. Cylinder bore = _____

M. Wall thickness = _____

N. Piston stroke = _____

O. Flywheel diameter = _____

P. Connecting rod journal width = _____

Q. Bolt length = _____

R. Size = _____

S. Thread length = _____

Completed ❑

3. It is quite common for the small engine technician to convert fractions to decimals or decimals to fractions. Dimensions smaller than 1/64 of an inch are typically expressed in decimal form. A conversion chart is a convenient way to change from fractions to decimals and from decimals to fractions. Use the *Decimal Equivalents of 8ths, 16ths, 32nds, and 64ths* table in the Appendix of the ***Small Gas Engines*** textbook to fill in the missing values in the following table.

	Fraction	Decimal
A.	3/8	
B.		.5625
C.	11/64	
D.		.84375
E.	13/64	
F.		.390625
G.	19/32	
H.		.4375
I.	3/64	
J.		.96875
K.	5/32	
L.		.6875
M.	25/32	
N.		.53125
O.	13/16	

Completed ❑

Name _____

4. Occasionally, a small engine technician may need to convert between metric and US customary units. Use the *Millimeter Conversion Chart* in the Appendix of the ***Small Gas Engines*** textbook to complete the following table.

	Millimeters	Inches
A.	8.5	_____
B.	_____	.8957
C.	41	_____
D.	_____	.6004
E.	83.50	_____
F.	_____	4.3405
G.	54.75	_____
H.	_____	3.0118
I.	108.75	_____
J.	_____	4.8917
K.	34.75	_____
L.	_____	2.3819
M.	80.25	_____
N.	_____	3.7203
O.	42.75	_____

Completed ❑

5. Use a telescoping gauge and standard outside micrometer to measure the inside diameter of a test cylinder provided by your instructor.

   If the cylinder has an identification label, record it here: _____

   What is the inside diameter of this cylinder? _____

   If the cylinder was measured with US customary micrometer, convert the value about to millimeters. If the cylinder was measured with a metric micrometer, convert the measurement to millimeters. Write the converted value here: _____ Completed ❑

6. Use a standard micrometer to measure the thickness of a feeler gauge blade.

   Does your reading correspond to the thickness of the blade? _____

   If not, clean the blade and the micrometer measuring surfaces and measure again.

   Does your reading correspond now? _____

   If not, check the calibration of the micrometer. (See the *Cleaning and Calibrating a Micrometer* section in Chapter 2 of the textbook.) Completed ❑

7. Use a metric micrometer and measure the outside diameter of a sample cylinder provided by your instructor. If there is an identification label on the cylinder, record it in the space provided.

   Cylinder identification: _____

   The reading is _____ mm.

   Completed ❑

8. Use a standard, US customary outside micrometer to measure the thickness of a sample block provided by your instructor. If there is an identification label on the block, record it in the space provided.

   Block identification: _____

   Thickness of the block: _____".

   Convert the measurement above into millimeters using a conversion chart: _____ mm.

   Next, measure the thickness of the block with a metric micrometer: _____ mm.

   Does the thickness measured in millimeters match the thickness measured in inches and converted to millimeters? _____

   If the thickness values do not match, what could be the cause? _____

   _____

   _____

   Completed ❑

9. Attach the magnetic base of a dial indicator to a surface plate or to another clean, flat metal surface. Place a bar sample provided by your instructor on the surface plate. If the sample bar has an identification label, record it in the space provided.

   Metal bar identification: _____

   Adjust the dial indicator so that the spindle touches the top of the metal bar. Zero out the dial indicator. Slide the metal bar along the plate.

   Is there any change in the reading showing on the dial face? _____

   If so, how much? _____

   Completed ❑

10. Use a small hole gauge to measure the inside diameter of a sample tube provided by your instructor. If the tube has an identification label, record it in the space provided.

    Tube identification: _____

    Inner diameter of tube: _____".

    Completed ❑

11. Pick out a random bolt and measure its diameter and thread pitch with a thread pitch gauge.

    Diameter: _____ Pitch: _____

    Completed ❑

12. Clamp a .50-13 UNC × 2 hex head bolt in a machinist's vise. Use a torque wrench and a socket to apply 20 ft-lb of torque to the bolt. The equivalent torque in inch pounds would be _____.

    Completed ❑

Instructor's Initials _____

Date _____

Millimeter Conversion Chart

mm	In.	15	= .5905	30	= 1.1811	45	= 1.7716	60	= 2.3622	75	= 2.9527	90	= 3.5433	105	= 4.1338	120	= 4.7244
0.25	= .0098	15.25	= .6004	30.25	= 1.1909	45.25	= 1.7815	60.25	= 2.3720	75.25	= 2.9626	90.25	= 3.5531	105.25	= 4.1437	120.25	= 4.7342
0.50	= .0197	15.50	= .6102	30.50	= 1.2008	45.50	= 1.7913	60.50	= 2.3819	75.50	= 2.9724	90.50	= 3.5630	105.50	= 4.1535	120.50	= 4.7441
0.75	= .0295	15.75	= .6201	30.75	= 1.2106	45.75	= 1.8012	60.75	= 2.3917	75.75	= 2.9823	90.75	= 3.5728	105.75	= 4.1634	120.75	= 4.7539
1	= .0394	16	= .6299	31	= 1.2205	46	= 1.8110	61	= 2.4016	76	= 2.9921	91	= 3.5827	106	= 4.1732	121	= 4.7638
1.25	= .0492	16.25	= .6398	31.25	= 1.2303	46.25	= 1.8209	61.25	= 2.4114	76.25	= 3.0020	91.25	= 3.5925	106.25	= 4.1831	121.25	= 4.7736
1.50	= .0591	16.50	= .6496	31.50	= 1.2402	46.50	= 1.8307	61.50	= 2.4213	76.50	= 3.0118	91.50	= 3.6024	106.50	= 4.1929	121.50	= 4.7885
1.75	= .0689	16.75	= .6594	31.75	= 1.2500	46.75	= 1.8405	61.75	= 2.4311	76.75	= 3.0218	91.75	= 3.6122	106.75	= 4.2027	121.75	= 4.7933
2	= .0787	17	= .6693	32	= 1.2598	47	= 1.8504	62	= 2.4409	77	= 3.0315	92	= 3.6220	107	= 4.2126	122	= 4.8031
2.25	= .0886	17.25	= .6791	32.25	= 1.2697	47.25	= 1.8602	62.25	= 2.4508	77.25	= 3.0413	92.25	= 3.6319	107.25	= 4.2224	122.25	= 4.8130
2.50	= .0984	17.50	= .6890	32.50	= 1.2795	47.50	= 1.8701	62.50	= 2.4606	77.50	= 3.0512	92.50	= 3.6417	107.50	= 4.2323	122.50	= 4.8228
2.75	= .1083	17.75	= .6988	32.75	= 1.2894	47.75	= 1.8799	62.75	= 2.4705	77.75	= 3.0610	92.75	= 3.6516	107.75	= 4.2421	122.75	= 4.8327
3	= .1181	18	= .7087	33	= 1.2992	48	= 1.8898	63	= 2.4803	78	= 3.0709	93	= 3.6614	108	= 4.2520	123	= 4.8425
3.25	= .1280	18.25	= .7185	33.25	= 1.3091	48.25	= 1.8996	63.25	= 2.4901	78.25	= 3.0807	93.25	= 3.6713	108.25	= 4.2618	123.25	= 4.8524
3.50	= .1378	18.50	= .7283	33.50	= 1.3189	48.50	= 1.9094	63.50	= 2.5000	78.50	= 3.0905	93.50	= 3.6811	108.50	= 4.2716	123.50	= 4.8622
3.75	= .1476	18.75	= .7382	33.75	= 1.3287	48.75	= 1.9193	63.75	= 2.5098	78.75	= 3.1004	93.75	= 3.6909	108.75	= 4.2815	123.75	= 4.8720
4	= .1575	19	= .7480	34	= 1.3386	49	= 1.9291	64	= 2.5197	79	= 3.1102	94	= 3.7008	109	= 4.2913	124	= 4.8819
4.25	= .1673	19.25	= .7579	34.25	= 1.3484	49.25	= 1.9390	64.25	= 2.5295	79.25	= 3.1201	94.25	= 3.7106	109.25	= 4.3012	124.25	= 4.8917
4.50	= .1772	19.50	= .7677	34.50	= 1.3583	49.50	= 1.9488	64.50	= 2.5394	79.50	= 3.1299	94.50	= 3.7205	109.50	= 4.3110	124.50	= 4.9016
4.75	= .1870	19.75	= .7776	34.75	= 1.3681	49.75	= 1.9587	64.75	= 2.5492	79.75	= 3.1398	94.75	= 3.7303	109.75	= 4.3209	124.75	= 4.9114
5	= .1968	20	= .7874	35	= 1.3779	50	= 1.9685	65	= 2.5590	80	= 3.1496	95	= 3.7401	110	= 4.3307	125	= 4.9212
5.25	= .2067	20.25	= .7972	35.25	= 1.3878	50.25	= 1.9783	65.25	= 2.5689	80.25	= 3.1594	95.25	= 3.7500	110.25	= 4.3405	125.25	= 4.9311
5.50	= .2165	20.50	= .8071	35.50	= 1.3976	50.50	= 1.9882	65.50	= 2.5787	80.50	= 3.1693	95.50	= 3.7598	110.50	= 4.3504	125.50	= 4.9409
5.75	= .2264	20.75	= .8169	35.75	= 1.4075	50.75	= 1.9980	65.75	= 2.5886	80.75	= 3.1791	95.75	= 3.7697	110.75	= 4.3602	125.75	= 4.9508
6	= .2362	21	= .8268	36	= 1.4173	51	= 2.0079	66	= 2.5984	81	= 3.1890	96	= 3.7795	111	= 4.3701	126	= 4.9606
6.25	= .2461	21.25	= .8366	36.25	= 1.4272	51.25	= 2.0177	66.25	= 2.6083	81.25	= 3.1988	96.25	= 3.7894	111.25	= 4.3799	126.25	= 4.9705
6.50	= .2559	21.50	= .8465	36.50	= 1.4370	51.50	= 2.0276	66.50	= 2.6181	81.50	= 3.2087	96.50	= 3.7992	111.50	= 4.3898	126.50	= 4.9803
6.75	= .2657	21.75	= .8563	36.75	= 1.4468	51.75	= 2.0374	66.75	= 2.6279	81.75	= 3.2185	96.75	= 3.8090	111.75	= 4.3996	126.75	= 4.9901
7	= .2756	22	= .8661	37	= 1.4567	52	= 2.0472	67	= 2.6378	82	= 3.2283	97	= 3.8189	112	= 4.4094	127	= 5.0000
7.25	= .2854	22.25	= .8760	37.25	= 1.4665	52.25	= 2.0571	67.25	= 2.6476	82.25	= 3.2382	97.25	= 3.8287	112.25	= 4.4193		
7.50	= .2953	22.50	= .8858	37.50	= 1.4764	52.50	= 2.0669	67.50	= 2.6575	82.50	= 3.2480	97.50	= 3.8386	112.50	= 4.4291		
7.75	= .3051	22.75	= .8957	37.75	= 1.4862	52.75	= 2.0768	67.75	= 2.6673	82.75	= 3.2579	97.75	= 3.8484	112.75	= 4.4390		
8	= .3150	23	= .9055	38	= 1.4961	53	= 2.0866	68	= 2.6772	83	= 3.2677	98	= 3.8583	113	= 4.4488		
8.25	= .3248	23.25	= .9153	38.25	= 1.5059	53.25	= 2.0965	68.25	= 2.6870	83.25	= 3.2776	98.25	= 3.8681	113.25	= 4.4587		
8.50	= .3346	23.50	= .9252	38.50	= 1.5157	53.50	= 2.1063	68.50	= 2.6968	83.50	= 3.2874	98.50	= 3.8779	113.50	= 4.4685		
8.75	= .3445	23.75	= .9350	38.75	= 1.5256	53.75	= 2.1161	68.75	= 2.7067	83.75	= 3.2972	98.75	= 3.8878	113.75	= 4.4783		
9	= .3543	24	= .9449	39	= 1.5354	54	= 2.1260	69	= 2.7165	84	= 3.3071	99	= 3.8976	114	= 4.4882		
9.25	= .3642	24.25	= .9547	39.25	= 1.5453	54.25	= 2.1358	69.25	= 2.7264	84.25	= 3.3169	99.25	= 3.9075	114.25	= 4.4980		
9.50	= .3740	24.50	= .9646	39.50	= 1.5551	54.50	= 2.1457	69.50	= 2.7362	84.50	= 3.3268	99.50	= 3.9173	114.50	= 4.5079		
9.75	= .3839	24.75	= .9744	39.75	= 1.5650	54.75	= 2.1555	69.75	= 2.7461	84.75	= 3.3366	99.75	= 3.9272	114.75	= 4.5177		
10	= .3937	25	= .9842	40	= 1.5748	55	= 2.1653	70	= 2.7559	85	= 3.3464	100	= 3.9370	115	= 4.5275		
10.25	= .4035	25.25	= .9941	40.25	= 1.5846	55.25	= 2.1752	70.25	= 2.7657	85.25	= 3.3563	100.25	= 3.9468	115.25	= 4.5374		
10.50	= .4134	25.50	= 1.0039	40.50	= 1.5945	55.50	= 2.1850	70.50	= 2.7756	85.50	= 3.3661	100.50	= 3.9567	115.50	= 4.5472		
10.75	= .4232	25.75	= 1.0138	40.75	= 1.6043	55.75	= 2.1949	70.75	= 2.7854	85.75	= 3.3760	100.75	= 3.9665	115.75	= 4.5571		
11	= .4331	26	= 1.0236	41	= 1.6142	56	= 2.2047	71	= 2.7953	86	= 3.3858	101	= 3.9764	116	= 4.5669		
11.25	= .4429	26.25	= 1.0335	41.25	= 1.6240	56.25	= 2.2146	71.25	= 2.8051	86.25	= 3.3957	101.25	= 3.9862	116.25	= 4.5768		
11.50	= .4528	26.50	= 1.0433	41.50	= 1.6339	56.50	= 2.2244	71.50	= 2.8150	86.50	= 3.4055	101.50	= 3.9961	116.50	= 4.5866		
11.75	= .4626	26.75	= 1.0531	41.75	= 1.6437	56.75	= 2.2342	71.75	= 2.8248	86.75	= 3.4153	101.75	= 4.0059	116.75	= 4.5964		
12	= .4724	27	= 1.0630	42	= 1.6535	57	= 2.2441	72	= 2.8346	87	= 3.4252	102	= 4.0157	117	= 4.6063		
12.25	= .4823	27.25	= 1.0728	42.25	= 1.6634	57.25	= 2.2539	72.25	= 2.8445	87.25	= 3.4350	102.25	= 4.0256	117.25	= 4.6161		
12.50	= .4921	27.50	= 1.0827	42.50	= 1.6732	57.50	= 2.2638	72.50	= 2.8543	87.50	= 3.4449	102.50	= 4.0354	117.50	= 4.6260		
12.75	= .5020	27.75	= 1.0925	42.75	= 1.6831	57.75	= 2.2736	72.75	= 2.8642	87.75	= 3.4547	102.75	= 4.0453	117.75	= 4.6358		
13	= .5118	28	= 1.1024	43	= 1.6929	58	= 2.2835	73	= 2.8740	88	= 3.4646	103	= 4.0551	118	= 4.6457		
13.25	= .5217	28.25	= 1.1122	43.25	= 1.7028	58.25	= 2.2933	73.25	= 2.8839	88.25	= 3.4744	103.25	= 4.0650	118.25	= 4.6555		
13.50	= .5315	28.50	= 1.1220	43.50	= 1.7126	58.50	= 2.3031	73.50	= 2.8937	88.50	= 3.4842	103.50	= 4.0748	118.50	= 4.6653		
13.75	= .5413	28.75	= 1.1319	43.75	= 1.7224	58.75	= 2.3130	73.75	= 2.9035	88.75	= 3.4941	103.75	= 4.0846	118.75	= 4.6752		
14	= .5512	29	= 1.1417	44	= 1.7323	59	= 2.3228	74	= 2.9134	89	= 3.5039	104	= 4.0945	119	= 4.6850		
14.25	= .5610	29.25	= 1.1516	44.25	= 1.7421	59.25	= 2.3327	74.25	= 2.9232	89.25	= 3.5138	104.25	= 4.1043	119.25	= 4.6949		
14.50	= .5709	29.50	= 1.1614	44.50	= 1.7520	59.50	= 2.3425	74.50	= 2.9331	89.50	= 3.5236	104.50	= 4.1142	119.50	= 4.7047		
14.75	= .5807	29.75	= 1.1713	44.75	= 1.7618	59.75	= 2.3524	74.75	= 2.9429	89.75	= 3.5335	104.75	= 4.1240	119.75	= 4.7146		

Decimal Equivalents of 8ths, 16ths, 32nds, 64ths

8ths	32nds	64ths	64ths
1/8 = .125	1/32 = .03125	1/64 = .015625	33/64 = .515625
1/4 = .250	3/32 = .09375	3/64 = .046875	35/64 = .546875
3/8 = .375	5/32 = .15625	5/64 = .078125	37/64 = .578125
1/2 = .500	7/32 = .21875	7/64 = .109375	39/64 = .609375
5/8 = .625	9/32 = .28125	9/64 = .140625	41/64 = .640625
3/4 = .750	11/32 = .34375	11/64 = .171875	43/64 = .703125
7/8 = .875	13/32 = .40625	13/64 = .203125	45/64 = .671875
16ths	15/32 = .46875	15/64 = .234375	47/64 = .734375
1/16 = .0625	17/32 = .53125	17/64 = .265625	49/64 = .765625
3/16 = .1875	19/32 = .59375	19/64 = .296875	51/64 = .796875
5/16 = .3125	21/32 = .65625	21/64 = .328125	53/64 = .828125
7/16 = .4375	23/32 = .71875	23/64 = .359375	55/64 = .859375
9/16 = .5625	25/32 = .78125	25/64 = .390625	57/64 = .890625
11/16 = .6875	27/32 = .84375	27/64 = .421875	59/64 = .921875
13/16 = .8125	29/32 = .90625	29/64 = .453125	61/64 = .953125
15/16 = .9375	31/32 = .96875	31/64 = .484375	63/64 = .984375

Rules Relative to the Circle

To find circumference—
Multiply diameter by 3.1416 ..... Or divide diameter by 0.03183

To find diameter—
Multiply circumference by 0.3183 ..... Or divide circumference by 3.1416

To find radius—
Multiply circumference by 0.15915 ..... Or divide circumference by 6.28318

To find side of an inscribed square—
Multiply diameter by 0.7071
Or multiply circumference by 0.2251 ..... Or divide circumference by 4.4428

To find side of an equal square—
Multiply diameter by 0.8862 ..... Or divide diameter by 1.1284
Or multiply circumference by 0.2821 ..... Or divide circumference by 3.545

Square—
A side multiplied by 1.4142 equals diameter of its circumscribing circle.
A side multiplied by 4.443 equals circumference of its circumscribing circle.
A side multiplied by 1.128 equals diameter of an equal circle.
A side multiplied by 3.547 equals circumference of an equal circle.

To find the area of a circle—
Multiply circumference by one-quarter of the diameter
Or multiply the square of diameter by 0.7854
Or multiply the square of circumference by 0.07958
Or multiply the square of 1/2 diameter by 3.1416