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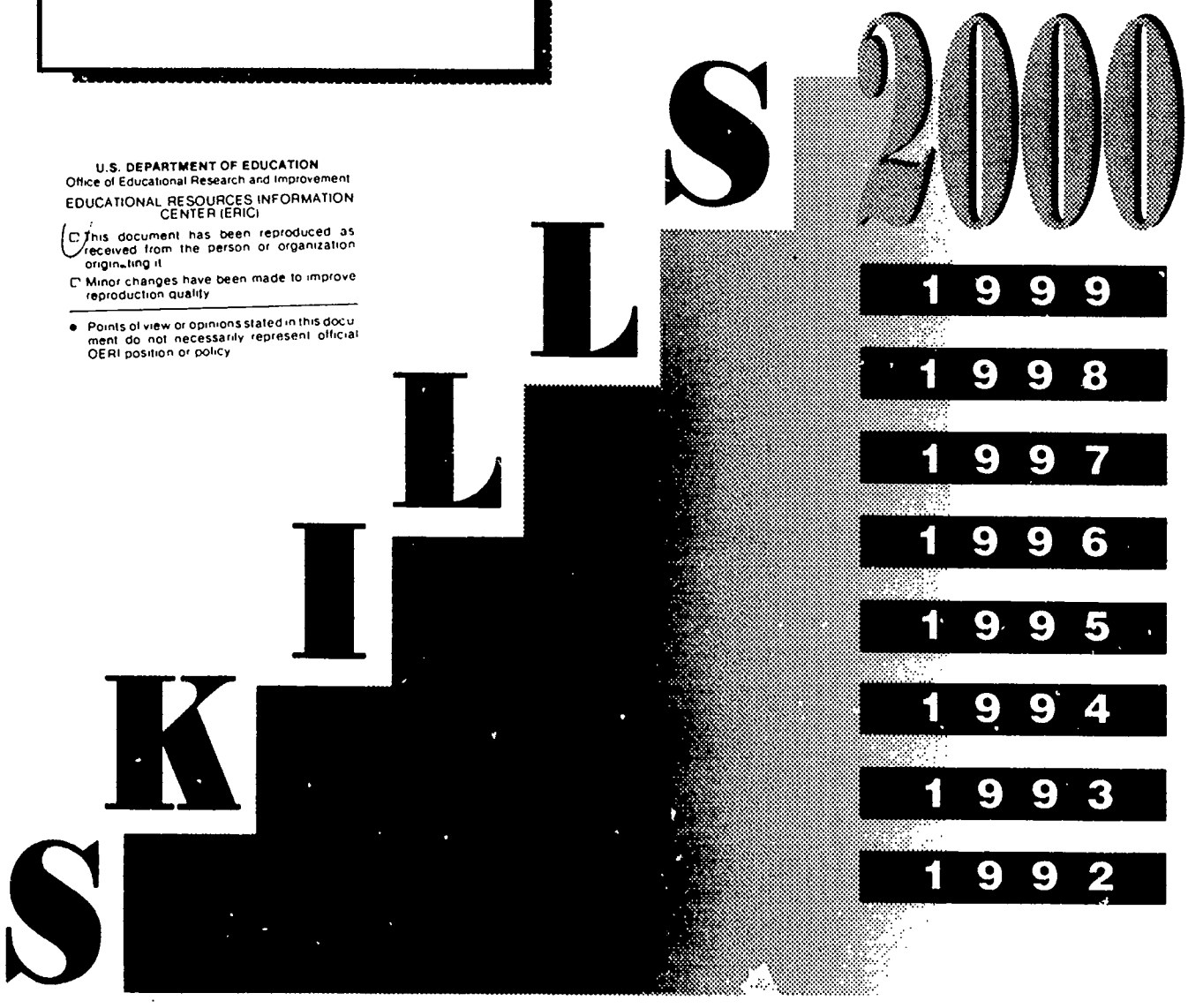
ABSTRACT

This workbook, designed for workplace literacy courses, contains materials for a basic course in blueprint reading. The course provides a review of mathematics, information about using measuring tools to read blueprints, an explanation of the principles of blueprint drawing, and instructions on interpreting blueprint specifications. Introductory materials include objectives, a topical outline, and a course outline. The workbook contains 10 lessons, 2 exercise sets, 3 units, 4 problem sets and a posttest. The following topics are covered: the scope of blueprint reading, measurement and dimensions, mathematics, hands-on experience with company blueprints, and review. The lessons and units include information sheets and problems to solve through mathematics and measurement. (KC)

Basic Blueprint Reading

MERCER COUNTY COMMUNITY COLLEGE

TRENTON • NEW JERSEY



Basic Blueprint Reading

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Mercer County Community College thanks Angie Deieso and Jean Meier, Senior Education Specialists/Curriculum Developers for creating this manual. Through their valuable contributions employees in manufacturing and service industries learned concepts relevant to their existing jobs and strategies for learning other tasks if the opportunity should arise.

BASIC BLUEPRINT READING

COURSE OUTLINE:

Blueprints will be a part of everyone's job in the future. Learn how to read, understand and use the tools necessary to read a blueprint, and how to understaind blueprints used in your work. There will be hands-on activities using the T-square, micrometer, 6 inch rule, tape measure, dial caliper and torque sensor to read blueprints. There will be a review of the math required for blueprint reading.

OBJECTIVES:

Upon completion of this course, students will be able to:

- complete mathematical problems required for blueprint reading
- use measuring tools required to read blueprints
- explain the principals used in blueprint drawing
- interpret blueprint specifications used on the job

TOPICAL OUTLINE:

- Scope of blueprint reading
- Measurement and dimensions, including measurement tools and math
- Math
- Hands-on experience with company blueprints
- Review

BASIC BLUEPRINT READING

COURSE OUTLINE

1. Introduction: Blueprints – "The Language of Industry" course contents and scope of lessons

   Overview of course
   Precourse assessment

2. Math: Review of mathematical concepts required to complete blueprint reading
   a. Common fractions and mixed numbers
   b. Decimal fractions and mixed numbers

3. Measurements: Introduction to use of and understanding tools and devices for measuring
   a. Scales -- English/metric
   b. Linear measurement and angular measurement
   c. Protractors and circular measurements
   d. Areas of regular shapes
   e. Triangles
   f. Tools of measurement
      1. Scales, i.e., steel rules, rulers
      2. Protractors
      3. Micrometers
      4. Vernier calipers

4. Angular Measurement
   a. Measurement of angles and threads (bolts)
   b. Circular functions
   c. Reading a protractor, plastic and metal
   d. Measurement of bolts, screws, and threaded devices; understanding tolerances.

5. Drawings:
   a. Basic drawings and sketches
   b. Orthographic representations

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   a. Basic drawings and sketches
   b. Orthographic representations

BASIC BLUEPRINT READING

6. Study of Company drawings:
    a. Exercises in understanding and reading drawings
    b. Questions and answers sessions

7. Review of course contents
    a. Summary
    b. Post course assessment
    c. Course evaluation

8. Materials
    a. Pencils/scales
    b. Compass, protractor
    c. Triangles
    d. Micrometers
    e. Calipers

BASIC BLUEPRINT READING ◆ LESSON 1

Arithmetic

Add the following:

1.
872
431
762
———
———

2.
200
473
871
19
916
354
527
———
———

3.
1235
65
476
918
3456
8
———
———

4. From a roll of wire, an electrician cuts several lengths (18', 12', 5', 17', 16', 9' & 22'). What is the total length cut off?

_____

5. Subtract:

a. 97 - 42 = _____
b. 863 - 219 = _____
c. 4321 - 1234 = _____
d. 9862 - 5317 = _____
e. 1538 - 762 = _____
f. 7,354,261 - 7,354,161 = _____
g. 267 - 138 = _____
h. 1,762,244 - 763,245 = _____

6. In a wire soldering glass, the instructor begins with 235 oz. of solder. At the end of the class, 74 oz. are left. How much has been used?

_____lbs. _____oz.

BASIC BLUEPRINT READING ◆ LESSON 2

1. Multiply the following:

42 X 6 =	_____	26 X 478 =	_____
57 X 8 =	_____	39 X 874 =	_____
93 X 4 =	_____	212 X 413 =	_____
127 X 18 =	_____	3450 X 6234 =	_____

2. A company has an order for 536 sheet metal boxes. Each box uses 27 sq. ft. of 20 Ga. material. How many sq. ft. does it take to fill the order?

_____

3. A shop power hacksaw operates at 126 strokes per minute. If it works continuously for 420 minutes, how many strokes does it make?

_____

4. A bar of steel 2" ∅ and 16 feet long weighs 180 lbs. How much would 36 bars weigh?

_____

5. A shop is lighted by 34 fixtures, each with 2 tubes (fluorescent 40 w. each). How much wattage is consumed if all lights were turned on at the same time?

_____

6. A band saw blade measures 11 feet in length. The blade has 13 teeth per inch. How many teeth does the blade have?

_____

BASIC BLUEPRINT READING ◆ LESSON 3

1. Divide the following:

5376 ÷ 16	=	_____	765,072 ÷ 264	=	_____
135,594 ÷ 186	=	_____	59,347 ÷ 17	=	_____
2,537,210 ÷ 673	=	_____	65,432,121,246 ÷ 9876	=	_____
666 ÷ 18	=	_____	731,411 ÷ 269	=	_____

2. A bar of flat steel (1" x 2" x 16') is to be cut into pieces, each 14" long. How many pieces of this length can be cut?

_____

3. A roll of insulated wire (#14 copper) contains 500 feet. How many pieces 27' long can be cut from this roll?

_____

4. A shop received 168 packages of sandpaper. Each package contained 24 sheets. If each sheet was cut into 4 parts, how many parts were made?

_____

BASIC BLUEPRINT READING ◆ LESSON 4

1. Change to denominations indicated:

a. $\frac{7}{8}$ to 64ths = _____

b. $\frac{1"}{4"}$ " to 8ths = _____

c. $\frac{1"}{2"}$ to 32nds = _____

d. $\frac{3"}{4"}$ to 16ths = _____

e. $\frac{13"}{16"}$ to 48ths = _____

2. Reduce improper fractions to mixed numbers:

a. $\frac{68}{8}$ = _____

b. $\frac{80}{7}$ = _____

c. $\frac{128}{64}$ = _____

e. $\frac{128}{64}$ = _____

f. $\frac{125}{25}$ = _____

h. $\frac{400}{4}$ = _____

3. Add the following:

$$\frac{1"}{2"} + \frac{57"}{64"} + \frac{13"}{16"} + \frac{7"}{8"} + \frac{3"}{4"} + \frac{15"}{32"} = \_\_\_\_\_$$

BASIC BLUEPRINT READING ◆ LESSON 5

1. A pattern maker has a board measuring 6 7/8" in length. A piece measuring 2 5/16" is cut from it. How much is left?

_____

2. An exhaust pipe for a home heater measures 18 3/4"∅. It is reduced to 9 7/16"∅. What is the difference in diameters?

_____

3. How much wire is needed to produce 35 pieces, each measuring 22 3/4" in length?

_____

4. A tool room has a board for brass checks which has 42 hooks in a horizontal line. The first and last hooks are 1 1/8" from the ends. The hooks in between are 1 1/4" apart. What is the length of the board?

_____

5. Sheet metal of 20 ga. steel measures 3' wide. A product component requires 286 sq. in. of material per piece. How many pieces can be produced from a robe which contains 1256 sq. ft?

_____

BASIC BLUEPRINT READING ◆ LESSON 6

1. A roll of 20 ga. steel sheet metal measures 3' in width and is 2,000 ft. in length.

   a. How many sq. ft. are contained on the roll? _____

   b. If 20 ga. steel weighs 6 oz./sq. ft, how much does the roll weigh? _____

   c. If sheet metal costs $.32/lin. ft, how much does the roll cost? _____

2. Write the following as decimals:

   a. $\frac{8}{10}$ = _____

   b. $\frac{15}{100}$ = _____

   c. $\frac{4}{10}$ = _____

   d. $\frac{231}{1000}$ = _____

   e. $\frac{453}{10000}$ = _____

   f. $\frac{27}{100}$ = _____

   g. $\frac{862}{1000000}$ = _____

   h. $\frac{419}{1000}$ = _____

   i. $\frac{785}{10000}$ = _____

   j. $\frac{843}{10000}$ = _____

3. Add:

   a. .015625 + 3.640625 + 5.359375 + .5000 + .046 = _____

   b. 3.640625 + .203125 + 23.7500 + 4.125 +6 = _____

   c. 5.359375 + 7 + .092 + 8.3678 + 2.0004 = _____

   d. .046 + .00002 + .653 + 8.1673 = _____

BASIC BLUEPRINT READING ◆ LESSON 7

1. Change to decimals:

a.	$\frac{1}{4}$ = _____		f.	$\frac{9}{16}$ = _____	
b.	$\frac{1}{2}$ = _____		g.	$\frac{27}{64}$ = _____	
c.	$\frac{1}{8}$ = _____		h.	$\frac{31}{32}$ = _____	
d.	$\frac{1}{16}$ = _____		i.	$\frac{51}{64}$ = _____	
e.	$\frac{1}{64}$ = _____		j.	$\frac{11}{64}$ = _____	

2. Change to fractions (nearest value on decimal chart):

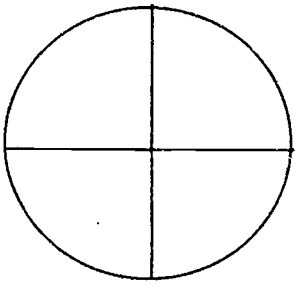
a.	.0625	=_____	f.	.2500	=_____
b.	.09375	=_____	g.	6.625	=_____
c.	.9375	=_____	h.	.875	=_____
d.	.8125	=_____	i.	.6875	=_____
e.	.750	=_____	j.	.125	=_____

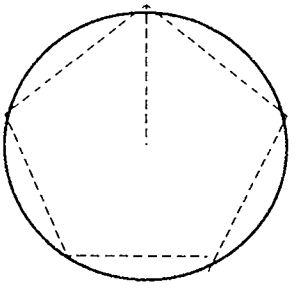
3. A shaft is tuned on a lathe. Dimension for the diameter is given as 2.35 ($^{+002}_{-001}$). Give the maximum diameter and minimum diameter shaft can be.

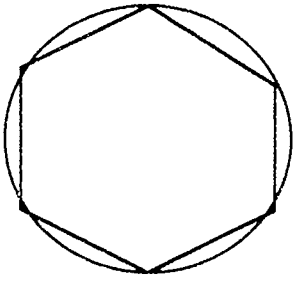
_____

BASIC BLUEPRINT READING ◆ LESSON 8

1. 2. 3.



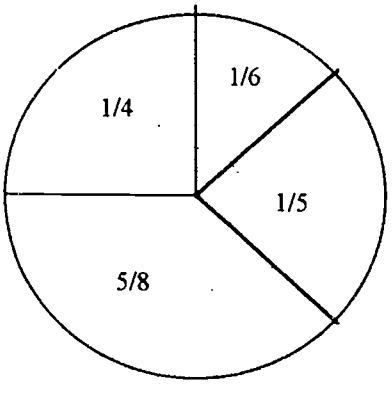


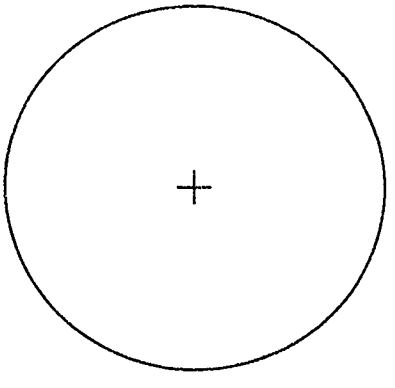


Divide circles given into parts as indicated.

1. Quarters 2. Fifths 3. Sixths

4. 5.





Draw angles inside circles.

BASIC BLUEPRINT READING ◆ LESSON 9

1. Following are basic relationships for plane figures:

   a. Radius of Circle = .5Dia

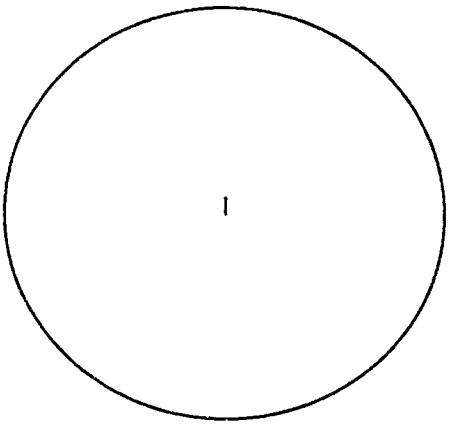
   b. Dia. = 2r

   c. Rectangle Area = L x W

2. Draw and show

   a. Radius _____

   b. Diameter _____



BASIC BLUEPRINT READING ◆ LESSON 10

1. Perform the indicated operation after conversion to decimals.

a. $3\frac{7}{8} + 4\frac{1}{16} =$ _____

b. $\frac{41}{64} + \frac{3}{8} =$ _____

c. $\frac{1}{2} + \frac{3}{4} =$ _____

d. $1\frac{1}{8} + \frac{3}{16} =$ _____

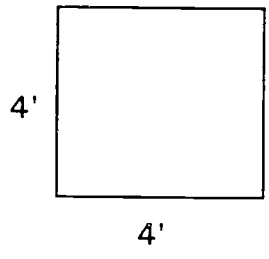
e. $5\frac{1}{2} + 7\frac{3}{4} =$ _____

2. A room measures 16.5' X 13'. What is its area in square feet?

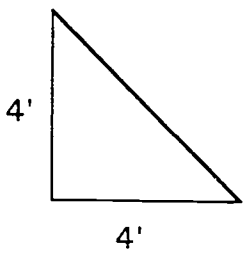
_____

3. Find the area of each figure in square feet.

a.



b.



a. _____ b. _____

BASIC BLUEPRINT READING ◆ EXERCISE 1

1. From a roll of wire an electrician cuts several lengths (18', 12', 5', 17', 16', 9', 22'). What was the total length cut off?

_____

2. In making a repair a mechanic uses 27 cotter pins, 63 washers, 19 nuts, 5 gaskets, 8 wrist pins and 8 bushings. How many parts does he use?

_____

3. A sheet metal drawing is designed to permit a production rate of 600 parts per hour. Premium pay for this is 50¢/dozen. How much does the operator earn if he accomplishes this in 2 hours. (Base pay $7.50/hour)

_____

4. A roll of sheet metal stock contains 8240 lin. ft. of strip steel. It is shortened at a rate of 25 ft./min. on a production run which lasts 3.5 hours. How much stock remains on the roll?

_____

5. In making an electrical connection to a relay an electrician uses 6" of tape from a roll which contains 75 yds. How many of these connection can he make from the roll?

_____

If he can make 20 connections per hour. How long will the roll last?

_____

BASIC BLUEPRINT READING ◆ EXERCISE 1

6. An automatic lathe produces 4" dia. bolts of various lengths at a rate of 30 per min. Its production at this time was

1250	-	$1\frac{1"}{2}$ length	600	-	1" length
975	-	2" length	300	-	$\frac{3"}{4}$ length

How long did it operate to do this?

_____

7. A bottle filling operation involved filling a container with 8# water for flood relief. Victims were unloading the containers from a truck at a rate of 60 per minute. Unloading the truck required 75 minutes. What was the weight of the water unloaded?

_____

8. An auto trip began with a full tank of gasoline. The trip lasted 6 hours and consisted of 342 miles on refilling the tank. How many gallons were needed if the average fuel consumption rate was 27mpg?

_____

9. A pallet is being loaded by a press operator with his stampings which weigh 1.3# each. How many can he stack on the pallet if the fork lift operator has a weight limit of 800#?

_____

BASIC BLUEPRINT READING ◆ EXERCISE 1

10. An electric light bulb of 60 watts is one of 34 needed to light an area. How many watts are consumed by the bulbs when they are turned on? How much does it cost to keep the lights on for 8 hours if electricity costs 20¢/kilowatt hr.?
(1 kilowatt = 1000 watts)

11. A wooden container requires 216 nails to fabricate an order for 536 boxes is received. How many nails are required to complete the order? If there are 36 nails in one pound, how much do the nails for this job weigh?

12. A grinding wheel turns at a rate of 3600 rpm. It is equipped with a wheel which measures 37 inches in circumference. How many inches of grinding surface does this provide?

13. An automobile wheel travels 135 inches per revolution. How many revolutions are required in traveling a distance of 235 miles?

14. A roll of sheet steel is 150 feet long and 3 feet wide. How many pieces 3 feet long and 18" wide can be produced from this roll?

BASIC BLUEPRINT READING ◆ EXERCISE 2

1. A gallon of liquid weighs 8.5 lbs. How much does each of the following sized containers weigh?

   (a) 1 quart =
   (b) 1 pint =
   (c) 3 quarts =
   (d) 6 pints =

2. The liquid in a soft drink container weighs 10 oz/lb. How much does a container weigh whose contents measure?

   (a) 6 oz =
   (b) 8 oz =
   (c) 12 oz =
   (d) 32 oz =

BASIC BLUEPRINT READING

Table: Standard gauge tables for sheets, tubing, wire, and screws

Gage No.	United States Standard Revised Manufacturers' Gage For Sheets -- Hot and Cold Rolled Steel
6-0's	.46875
5-0's	.4375
4-0's	.40625
3-0's	.3750
2-0's	.34375
1-0	.3125
1	.28125
2	.26562
3	.2391
4	.2242
5	.2092
6	.1943
7	.1793
8	.1644
9	.1495
10	.1345
11	.1196
12	.1046
13	.0897
14	.0747
15	.0673
16	.0598
17	.0538
18	.0478
19	.0418
20	.0359
21	.0329
22	.0299
23	.0269
24	.0239
25	.0209
26	.0179
27	.0164
28	.0149
29	.0135
30	.0120
31	.01094
32	.01016
33	.00938
34	.00859
35	.00781
36	.00703
37	.00664
38	.00625

Conversion Table

Fractions	Decimals
1/64	.0156
1/32	.0313
3/64	.0469
1/16	.0625
5/64	.0781
3/32	.0938
7/64	.1094
1/8	.1250
9/64	.1406
5/32	.1563
11/64	.1719
3/16	.1875
13/64	.2031
7/32	.2188
15/64	.2344
1/4	.2500
17/64	.2656
9/32	.2813
19/64	.2969
5/16	.3125
21/64	.3281

Fractions	Decimals
11/32	.3438
23/64	.3594
3/8	.3750
25/64	.3906
13/32	.4063
27/64	.4219
7/16	.4375
29/64	.4531
15/32	.4688
31/64	.4844
1/2	.5000
33/64	.5156
17/32	.5313
35/64	.5469
9/16	.5625
37/64	.5781
19/32	.5938
39/64	.6094
5/8	.6250
41/64	.6406
21/32	.6563
43/64	.6719

Fractions	Decimals
11/16	.6875
45/64	.7031
23/32	.7188
47/64	.7344
3/4	.7500
49/64	.7656
25/32	.7813
51/64	.7969
13/16	.8125
53/64	.8281
27/32	.8438
55/64	.8594
7/8	.8750
57/64	.8906
29/32	.9063
59/64	.9219
15/16	.9375
61/64	.9531
31/32	.9688
63/64	.9844
1	1.000

Common Fractions and Mixed Numbers

A. Basic Skills:
- express fractions in lowest terms and as equivalent fractions
- express mixed numbers as improper fractions
- express improper fractions as mixed numbers
- comparison of fractions
- fractions as blueprint dimensions

Most measurements and calculations made by a machinist are not limited to whole numbers. Blueprint dimensions are often given as **fractions** and most measurement tools are graduated in **fractional units**.

Definitions:

Fractions

- a value which represents part of a whole
- expressed as $\frac{\text{numerator (x)}}{\text{denominator (y)}} ====> \frac{x}{y}$

e.g. $\frac{1}{2}$ $\frac{9}{16}$

Proper Fractions

- numerator is smaller than denominator

e.g. $\frac{3}{8}$ $\frac{15}{16}$

Improper Fractions

- numerator is larger than denominator

e.g. $\frac{11}{8}$ $\frac{13}{12}$

Mixed Numbers

- contains a whole number as well as a fraction

e.g. $1\frac{2}{3}$ $5\frac{1}{2}$

Lowest Terms

To express these fractions in lowest terms, "reduce" them by dividing both numerator and denominator by their greatest common factor.

Explanation:

$$\frac{6 \div 2}{16 \div 2} = \frac{3}{8} \qquad \frac{8 \div 8}{16 \div 8} = \frac{1}{2} \qquad \frac{12 \div 4}{16 \div 4} = \frac{3}{4}$$

Equivalent Fractions

To express these fractions as equivalent fractions with a new denominator:
(1) divide the original denominator into the new denominator and
(2) multiply both the numerator and denominator of the original fraction by the value obtained.

(1) $\frac{8}{16} = \frac{\quad}{32}$ $(32 \div 16 = 2)$

(2) $\frac{8 \times 2}{16 \times 2} = \frac{16}{32}$

Mixed Numbers and Improper Fractions

e.g. Mixed Number => Improper Fraction

$2\frac{1}{4}$ => $4 \times 2 + 1$ => $\frac{9}{4}$

Improper Fraction => Mixed Number

$\frac{7}{4}$ => $4\overline{)7}^{1}$ => $\frac{3}{4}$

Comparison of Fractions

To compare any two given fractions using $<$ (less than), $>$ (greater than), or $=$ (equal to), change them to equivalent fractions with common denominators:

example:

Which is bigger $\frac{3}{8}$ or $\frac{3}{16}$?

$$\frac{3}{8} = \frac{6}{16}$$

therefore

$$\frac{3}{8} > \frac{3}{16}$$

B. Addition/Subtraction Skills:
- determine least common denominator
- rewrite fractions as equivalent fractions using least common denominator
- add/subtract fractions and mixed numbers

A machinist must be able to add fractions and mixed numbers in order to **determine the distance between parts of a machined piece** and to **determine** depth of holes and cutouts. While making a part from a blueprint, a machinist often finds it necessary to express blueprint dimensions as working dimensions. Subtraction of fractions and mixed numbers is required to properly position a part on a machine, to establish hole locations, and to determine depths of cut.

To determine the LCD, find the smallest number into which all denominators divide into evenly.

e.g. The LCD for: $\frac{1}{8}$, $\frac{3}{4}$, $\frac{9}{16}$ is 16
because 8, 4, and 16 divide evenly into 16.

Adding Fractions/Mixed Numbers

To add fractions, express fractions as equivalent fractions with the LCD, add numerators, denominator remains the same. Reduce to lowest terms or express improper fractions as mixed numbers.

example: Add $\frac{1}{8} + \frac{3}{4}$

$$\frac{1}{8} = \frac{1}{8}$$

$$\frac{3}{4} = \frac{6}{8}$$

$$\frac{7}{8}$$

To add mixed numbers, add the whole numbers, add the fractions, combine whole numbers and fractions.

e.g.
$$4\frac{1}{2} = 4\frac{12}{24}$$
$$+ 2\frac{13}{24} = 2\frac{13}{24}$$

$$6\frac{25}{24} = 7\frac{1}{24}$$

Subtracting Fractions and Mixed Numbers

Follow addition rules, except:

If fractions cannot be subtracted, one whole unit must be borrowed and expressed as a fraction.

e.g. $9\frac{5}{8} = 9\frac{10}{16} => 8\frac{26}{16}$

$- 6\frac{15}{16} = 6\frac{15}{16} => - \quad 6\frac{15}{16}$

$2\frac{11}{16}$

C. Multiplication/Division Skills:
- multiply fractions and mixed numbers
- cancel common factors
- compute parts of a fractions
- compute threads per inch
- divide fractions and mixed numbers

In machine technology, multiplication and division of fractions and mixed numbers are used to determine distances between parts of a machined piece and to calculate pitch of screw heads.

Multiplying fractions

To multiply fractions, multiply across numerators and across denominators. Reduce to lowest terms.

e.g. $\frac{2}{3} \times \frac{9}{16} = \frac{18}{48} = \frac{3}{8}$

To multiply mixed numbers, express mixed numbers as improper fractions and multiply as fractions.

e.g. $3\frac{1}{2} \times 1\frac{3}{21} = \frac{7}{2} \times \frac{24}{21} = \frac{4}{1} = 4$

To determine a fractional part of a given amount, multiply the fractions.

e.g. What is half of $\frac{1}{16}$?

$$\frac{1}{2} \times \frac{1}{16} = \frac{1}{32}$$

e.g. What is twice as much as $\frac{3}{4}$?

$$\frac{2}{1} \times \frac{3}{4} = \frac{6}{4} = 1\frac{1}{2}$$

Dividing Fractions

To divide fractions, change to multiplication problem by inverting the divisor, and multiply as fractions.

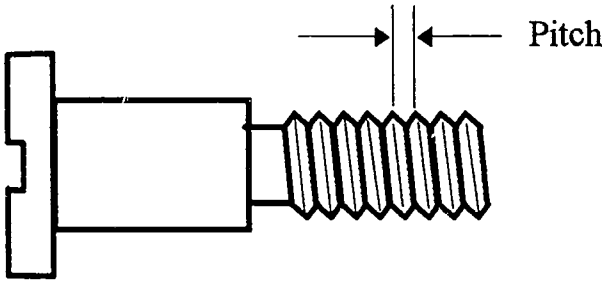
e.g. $\frac{5}{8} \div \frac{2}{3} =$

$\frac{5}{8} x \frac{3}{2} =$

$\frac{15}{16}$

Threads per inch

The pitch of a thread is the distance from a given point on one thread to the corresponding point on the next thread. Pitch is usually expressed as a fraction.



If the number of threads are known in a given length, divide the length by the number of threads to determine threads per inch.

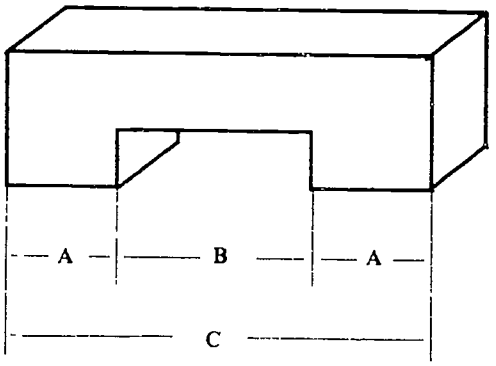
e.g. A screw is 5 inches long and has 45 threads. How many TPI?

45 ÷ 5 = 9 T.P.I.

D. Fractions as Dimensions

When measuring parts it is often necessary to determine lengths not measured, based on dimensions that are measured.

e.g. If dimensions for A and B are known, what is C?

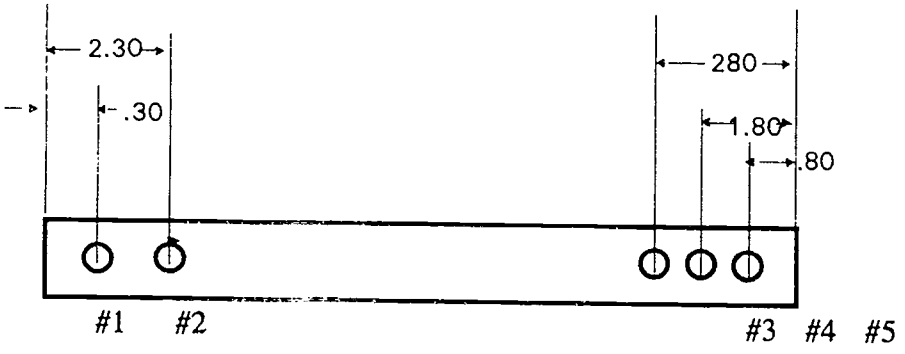


A = ″

B = 2″

C = ?

On a blueprint drawing, however, missing dimensions should not be calculated. Dimensions should be measured only as shown on the drawing.



For example: In the drawing above, holes #1 and 2 must be measured only from the left edge. Hole #3, 4 and 5 must be measured from the right edge.

E. Tolerances

- compute tolerances based on upper and lower limits of dimension

In industry, the tolerance of a part or component is the acceptable amount that the part or component may vary from a given size.

Definitions

Tolerance is the amount of variation permitted on the dimensions or surfaces of manufactured parts. Limits are the extreme permissible dimensions of a part. Tolerance is equal to the difference between the upper and lower limits of any specified dimension of a part.

The tolerance of the hole is:

$$3\frac{1"}{2} \quad \pm \quad \frac{1"}{8}$$

therefore, the diameter of a hole has

- an upper limit of $3\frac{5}{8}$ inches
- a lower limit of $3\frac{3}{8}$ inches

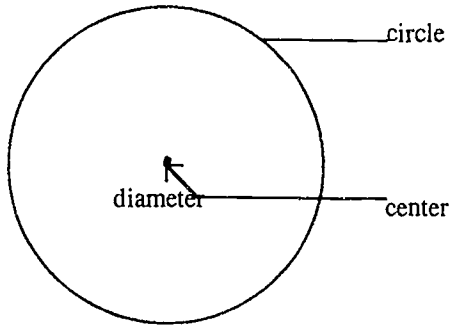
The tolerance interval is the difference between the upper and lower limit,

$$\frac{2}{8} \quad \text{or} \quad \frac{1}{4} \text{ inch.}$$

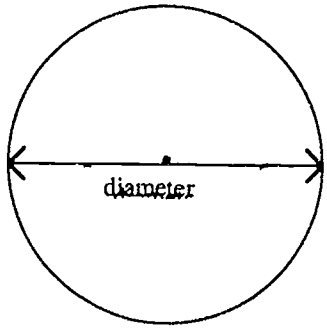
A basic dimension is the standard size from which the maximum and minimum limits are determined. Tolerances are shown with the amount of variation and the direction from the basic dimension the variation an occur.

F. Circles
- Calculating diameter and radius

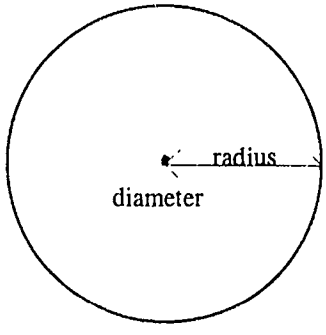
Circles are used repeatedly in drawings. A circle is a plane figure with each point on it an equal distance from a fixed point inside, called the center of the circle.



The diameter of the circle is the distance across the circle through the center.



The radius is the distance from the center of the circle to a point on the circle.



The diameter of a circle is equal to twice the radius.
The radius of a circle is equal to one-half the diameter.

BLUEPRINT READING ◆ PROBLEM SET 1

Common Fractions and Mixed Numbers

1. Express fractions in lowest terms.

$\frac{32}{32} =$ $\frac{15}{1} =$ $\frac{6}{8} =$

$\frac{0}{8} =$ $\frac{14}{16} =$ $\frac{12}{16} =$ $\frac{14}{64} =$

2. Express as equivalent fractions.

$\frac{5}{16} = \frac{\quad}{32}$ $\frac{1}{8} = \frac{\quad}{16}$ $\frac{15}{4} = \frac{\quad}{64}$

$\frac{12}{32} = \frac{\quad}{8}$ $\frac{7}{1} = \frac{\quad}{16}$ $\frac{10}{8} = \frac{\quad}{32}$

3. Express mixed numbers as improper fractions.

$6\frac{3}{4} =$ $2\frac{1}{8} =$ $4\frac{1}{2} =$ $6\frac{7}{8} =$

4. Express improper fractions as mixed numbers.

$\frac{11}{4} =$ $\frac{67}{16} =$ $\frac{70}{16} =$

5. Compare fractions using $<$. $>$, or $=$.

$\frac{13}{16} \quad \frac{3}{4}$ $\frac{15}{32} \quad \frac{30}{64}$

$\frac{1}{2} \quad \frac{8}{16}$ $\frac{3}{8} \quad \frac{24}{64}$

6. Determine the least common denominator for each set of fractions.

$\frac{1}{2}$ $\frac{1}{8}$ $\frac{1}{16}$ _____

$\frac{1}{4}$ $\frac{1}{16}$ $\frac{7}{8}$ _____

$\frac{3}{32}$ $\frac{1}{16}$ $\frac{5}{64}$ _____

7. Rewrite each of the above fractions as equivalent fractions using the least common denominator.

_____

_____

_____

8. Add the following fractions and mixed numbers.

$2\frac{1}{2} + 1\frac{3}{8} =$ _____ $\frac{1}{16} + \frac{3}{32} =$ _____

$3\frac{7}{8} + \frac{5}{16} =$ _____ $4\frac{3}{16} + \frac{1}{8}\ 5\frac{1}{4} =$ _____

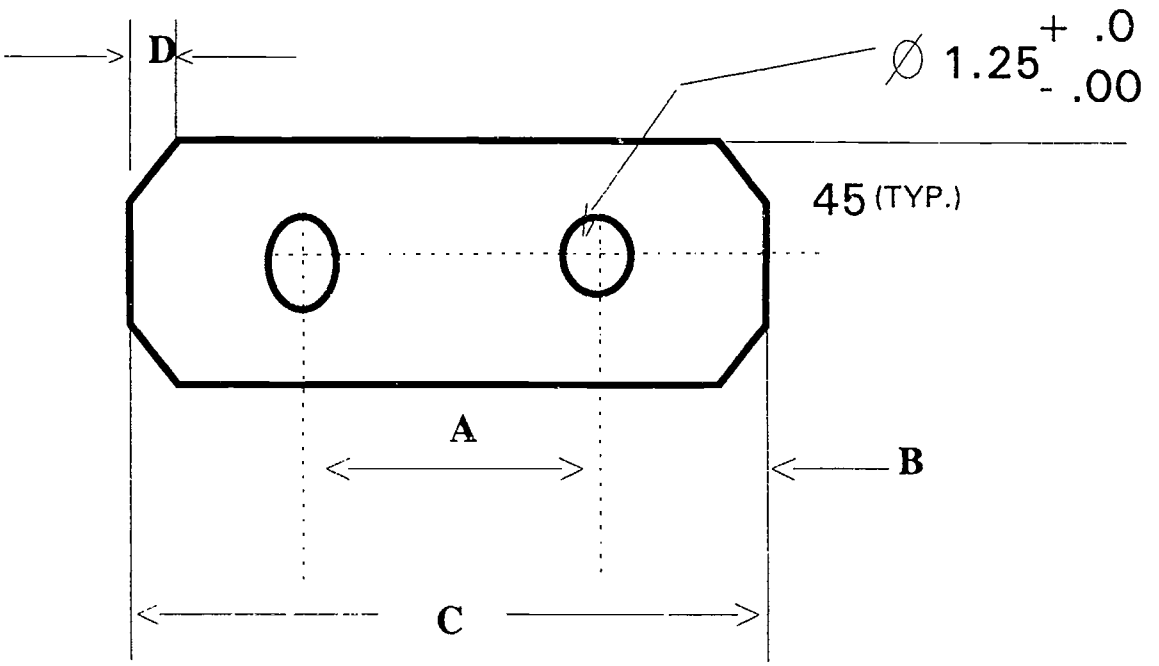
9. Subtract the following fractions and mixed numbers.

$\frac{5}{16} + \frac{3}{16} =$ _____ $\frac{7}{8} + \frac{3}{4} =$ _____

$\frac{9}{16} + \frac{13}{32} =$ _____ $8 - 5\frac{3}{4} =$ _____

$8\frac{3}{16} + 3\frac{7}{16} = \_\_\_\_\_$

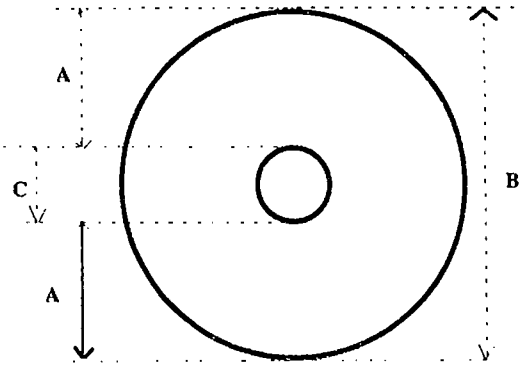
10. In this drawing of a plate, determine C.



A = $2\frac{1"}{8}$ B = $\frac{15"}{32}$ D = _____

C = _____

11. In this diagram of a washer, determine the diameter of the hole.



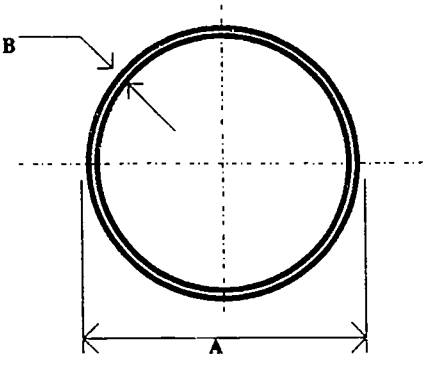
A = $1\frac{7"}{16}$ B = $4\frac{9"}{32}$

C = _____

12. A board is measured to be $5\frac{7"}{8}$ in length. A piece measuring $1\frac{5"}{16}$ is cut from it. How much is left?

_____

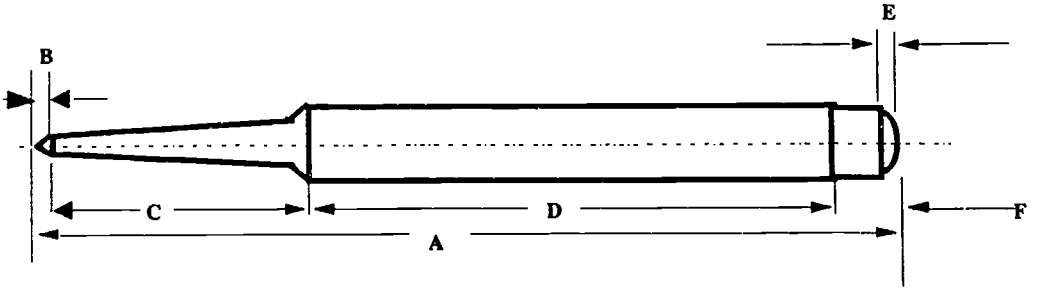
13. A pipe measures $4\frac{3"}{4}\varnothing$. It is $\frac{3"}{16}$ thick. Find the internal diameter.



$A = 4\frac{3"}{4}$ $B = \frac{3"}{16}$

_____

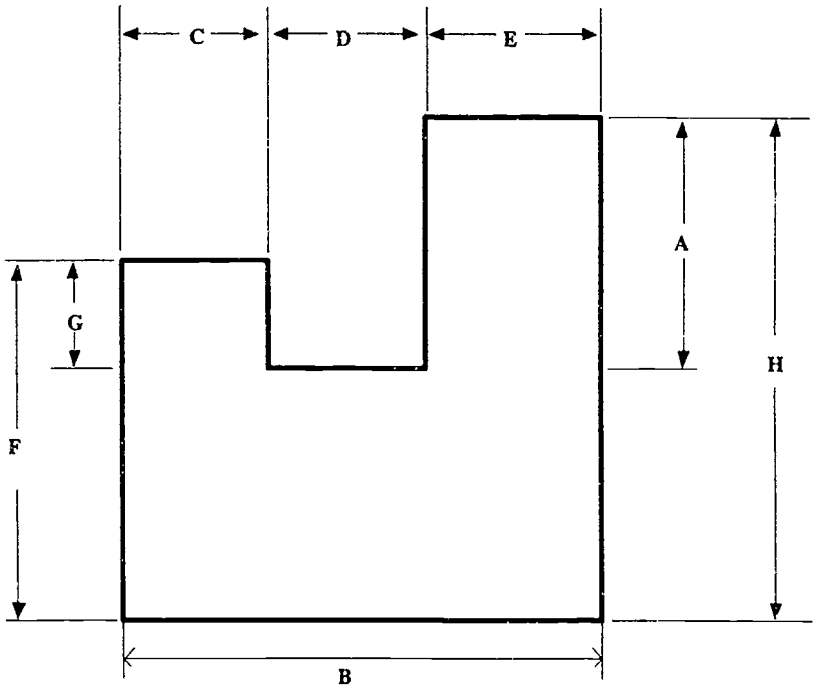
14. Find the overall length.



$B = \frac{3"}{32}$ $C = 2\frac{1"}{4}$ $D = 3"$ $E = \frac{3"}{32}$ $F = \frac{3"}{8}$

A = _____

15. Find dimensions & B on this support bracket.



$C = 1\frac{1"}{16}$ $D = 1\frac{3"}{32}$ $E = 1\frac{5"}{64}$ $F = 3\frac{7"}{8}$ $G = \frac{15"}{16}$ $H = 5\frac{1"}{16}$

A = _____

B = _____

16. Multiply the following as indicated.

$8 \times \frac{1}{2} =$_____ $\frac{3}{4} \times 12 =$_____ $\frac{3}{4} \times \frac{5}{16} =$_____

17. Divide the following.

$\frac{3}{8} \div \frac{1}{4} =$_____ $\frac{1}{2} \div \frac{1}{4} =$_____ $15 \div \frac{3}{8} =$_____

18 Determine the following.

What is $\frac{1}{2}$ of $\frac{3}{16}$? _____

What is half of $\frac{7}{8}$? _____

What number is twice as large as $\frac{1}{32}$? _____

19. The diameter of a circle is $4\frac{3"}{4}$. What is its radius?

_____

The radius of a circle is $\frac{3"}{8}$. What is its diameter?

_____

20. A screw 6 inches long has 48 threads. How many threads per inch are there?

_____

A screw has a pitch of $\frac{1"}{16}$. How many threads per inch are there?

_____

21. How much wire is needed to produce 38 pieces, each measuring $24\frac{3"}{8}$ in length?

_____

22. A room has a board for brass checks which has 48 hooks on a horizontal line. The first and last hooks are $1\frac{1"}{4}$ from the ends. The hooks in between are $1\frac{1"}{8}$ apart. What is the length of the board?

_____

23. A roll of sheet steel is 180 ft. long and 4 ft. wide. How many pieces 2 ft. long and 3 ft. wide can be produced from this roll?

_____

24. Complete the following table.

Given measurement	Tolerance	Upper limit	Lower limit	Tolerance interval
$3\frac{1}{2}$ in.	$\pm\frac{1}{8}$ in.	$3\frac{5}{8}$ in.	$3\frac{3}{8}$ in.	$\frac{1}{4}$ in.
$5\frac{3}{4}$ in.	$\pm\frac{1}{16}$ in.			
$6\frac{5}{8}$ in.	$\pm\frac{1}{32}$ in.			
$3\frac{7}{16}$ in.	$\pm\frac{1}{64}$ in.			
$\frac{9}{64}$ in.	$\pm\frac{1}{128}$ in.			

25 The drawing in figure I gives the locations and tolerances of 6 holes that are to be drilled in a length of iron.

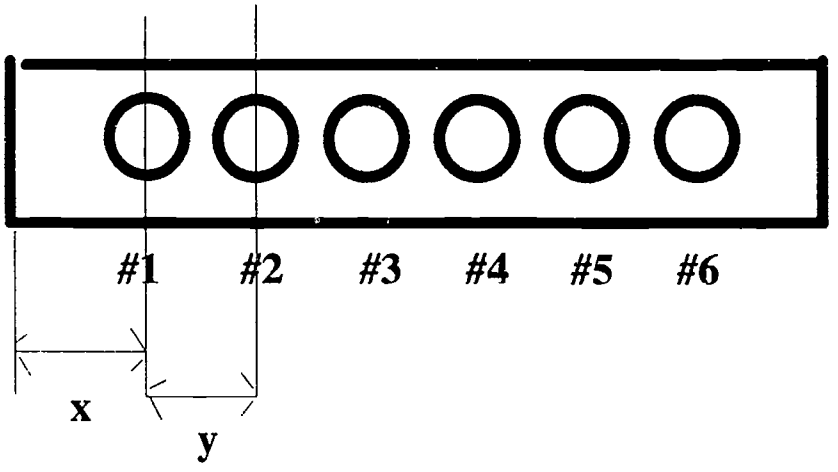
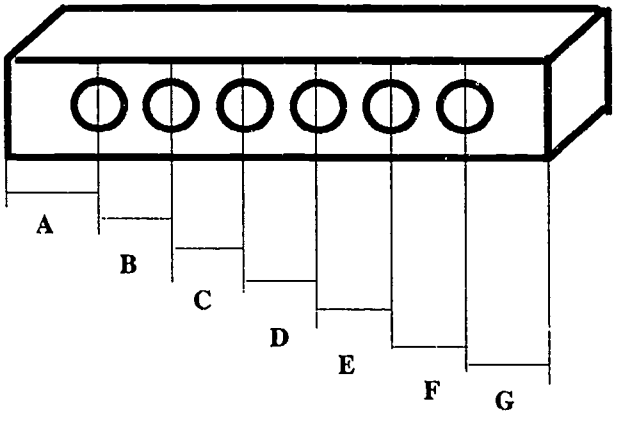


Figure I

$x = 4\frac{7"}{16} \pm \frac{1"}{8}$ $y = 6\frac{7"}{8} \pm \frac{1"}{32}$

Typical 2 places Typical 5 places

A machinist drills the holes and checks them for proper location. The actual locations of the drilled holes are shown in Figure II. Which holes are drilled out of tolerance?



$A = 4\frac{1"}{2}$ $B = 6\frac{15"}{16}$ $C = 6\frac{57"}{64}$ $D = 6\frac{54"}{64}$ $E = 6\frac{13"}{16}$ $F = 6\frac{1"}{4}$ $G = 4\frac{1"}{4}$

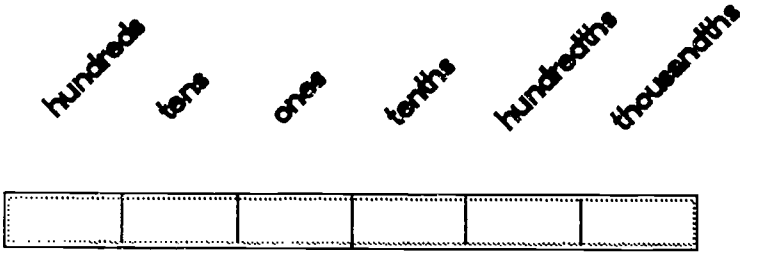
Decimal Fractions and Mixed Decimals

A. Basic Skills
- read and write decimal fractions using place value chart
- express common fractions as decimal fractions
- express decimal fractions as common fractions
- round decimal fractions

It is important to understand decimal fractions because most blueprints are dimensioned with decimal fractions rather than common fractions. However, if the blueprint dimensions of a part are given in fractional units, a machinist is usually required to express these fractional values as decimal working dimensions.

Decimal Fractions

The place value chart gives the value of the digits, with respect to the position from the decimal point.



To read a decimal fraction, read the number as a whole number, then say the name other place value where the last digit falls.

The following three numbers all have the same value:

0.5 is read as 5 tenths
0.50 is read as 50 hundredths
0.500 is read as 500 thousandths

Rounding Decimals

To round a decimal fraction, determine the number of decimal places required,

-if the digit to the right of this decimal place is less that 5, eliminate all the digits following it.

-if the digit to the right of this decimal place is 5 or more, add one to the last required digit and eliminate all the digits following it.

e.g. round 0.368 to 2 places (nearest hundredth)

$0.368 = 0.37$

Express Common Fractions as Decimal Fractions

To express a common fraction as a decimal fraction requires division of the numerator by the denominator.

.66...

With repeating decimals, the division should be carried out one more place than the number of places required in the answer, then rounded.

e.g. express $\frac{5}{7}$ as a 2 place decimal

e.g. $\frac{5}{7} = 5 \div 7 = 7\overline{)5.000}^{.714} = .71$

Express Decimal Fractions as Common Fractions

Read the place value of the last digit.

e.g. $0.357 = \frac{375}{1000} = \frac{3}{8}$

B. Addition/Subtraction Skills
- add/subtract decimals, mixed decimals and whole numbers
- add/subtract decimal fractions

Adding and subtracting decimal fractions are required at various stages in the production of most products and parts. It is necessary to add and subtract decimals in order to compute tolerances, to determine locations and lengths of cuts, and to inspect finished parts.

Adding and Subtracting Decimal Fractions

To add decimal fractions, (1) arrange the numbers so that the decimal points are directly under each other, (2) add, as with whole numbers and (3) place decimal point in the answer directly under the other decimal points.

e.g. Add 5 + .02

```
  5.
+ .02
-----
 5.02
```

Subtract 3.07 - .005

```
 3.070
-.005
-----
 3.065
```

Note: To reduce the possibility of error, place zeroes in all place values which have no digits.

C. Multiplication and Division Skills
- multiply and divide decimal fractions
- multiply and divide decimals, mixed decimals, and whole numbers

A machinist must readily be able to multiply and divide decimal fractions for computing, for determining lengths, and for solving problem involving geometry.

Multiplying Decimal Fractions

To multiply decimal fractions, multiply using the same procedure as with whole numbers. Place the decimal point in the answer the same number of decimal places as there are in both numbers being multiplied.

e.g.
$$\begin{array}{rl} 50.123 & (3 \text{ places}) \\ \times \quad 0.87 & (2 \text{ places}) \\ \hline 43.60701 & (5 \text{ places}) \end{array}$$

Dividing Decimal Fractions

To divide decimal fractions, (1) move the decimal point of the divisor as many places to the right as are necessary to make the divisor a whole number, (2) move the decimal point in the dividend the same number of places as were moved in the divisor, (3) place the decimal point in the quotient directly above the decimal point in the dividend, (4) add zeros to the dividend if necessary, and (5) divide as with whole numbers. Round as required.

e.g. Divide 0.643 by 0.28. Round to 3 decimal places

$$\begin{array}{r} 2.2964 \\ .28\overline{)0.643000} \end{array} \quad \approx \quad 2.296$$

f) Decimal Equivalents

- read and write decimal or fraction equivalents using decimal equivalent table

Generally, fractional blueprint dimensions are given in multiples of 64ths or an inch. A machinist is often required to express these fractional dimensions as decimal equivalents for machine settings. Computation and the chances of error can be reduced by using the decimal equivalent table.

BLUEPRINT READING ◆ PROBLEM SET 2

Decimal Fractions and Mixed Decimals

1. Express each decimal in words.

   0.004 = _____

   0.021 = _____

   7.1 = _____

2. Express each of the following in decimal form.

   five and two hundredths _____

   sixty-five thousandths _____

   three and four ten-thousandths _____

3. Express each common fraction as a decimal number.

   $\frac{3}{100}$ = _____ $\frac{11}{1000}$ = _____

   $5\frac{9}{10}$ = _____ $\frac{125}{1000}$ = _____

4. Express each decimal fraction as a common fraction.

   0.7 = _____ 0.11 = _____

   0.842 = _____ 14.613 = _____

5. Round each number in the left column to the place value indicated in each of the other columns.

	tenths	hundredths
5.732		
302.855		
12.0731		
5.897		
4.302		

6. Compare these decimals. Indicate which one is the smallest in each pair.

.001	.0010
.029	.03
.067	.076
.01	.009

7. Add the following.

137.64 + 7 + 0.008 + 6.1 63 + 4.7 + 19.45

8. Subtract the following:

159 - 72.4 4.7 - 3.12 140 - 16.412

9. Sheets of steel are stacked to a height of 4" on a pallet. The metal sheets are .025" thick. How many are on the pallet?

10. A roll of sheet steel is 144 feet long and 3 feet wide. How many pieces 3 feet long and 2 feet wide can be produced from this roll?

11. A roll of sheet metal stock contains 8240 lin. ft. of strip steel. It is shortened at a rate of 25.5 ft./min. on a production run which lasts 3 hours. How much stock remains on the roll?

12. An automatic lathe produces .4" diameter bolts of various lengths at a rate of 30 per min. It ran for a total of 3.25 hours. How many bolts were produced?

13. A company has an order for 536 sheet metal boxes. Each box uses 27 sq. ft. of 20 gauge. material. How many sq. ft. does it take to fill the order?

14. A bar of steel 3" ∅ (diameter) and 18 feet long weighs 180 lbs. How much would 36 bars weigh?

15. A shop received 170 packages of sandpaper. Each package contained 25 sheets. If each sheet was cut into 4 parts, how many parts were made?

16. A board is measured to be 6 inches in length. A piece measuring .95 inches is cut from it. How much is left?

17. Multiply the following.

    3.7 x 0.15 14.1 x 1.7

18. Divide the following: Round to the nearest hundredth.

    36 ÷ 1.2 75 ÷ 20.4

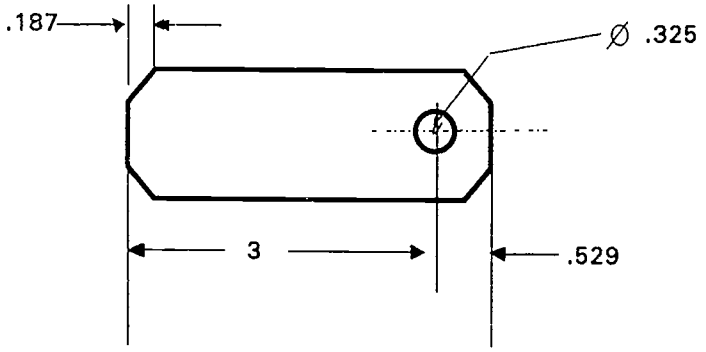
19. Determine the following:

    What is half of .001?

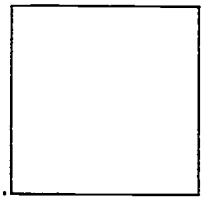
    What is half of .05?

20. A pallet is being loaded by an operator with his stampings which weigh 2.4 pounds each. How many can he stack on the pallet if the operator has a weight limit of 600 pounds?

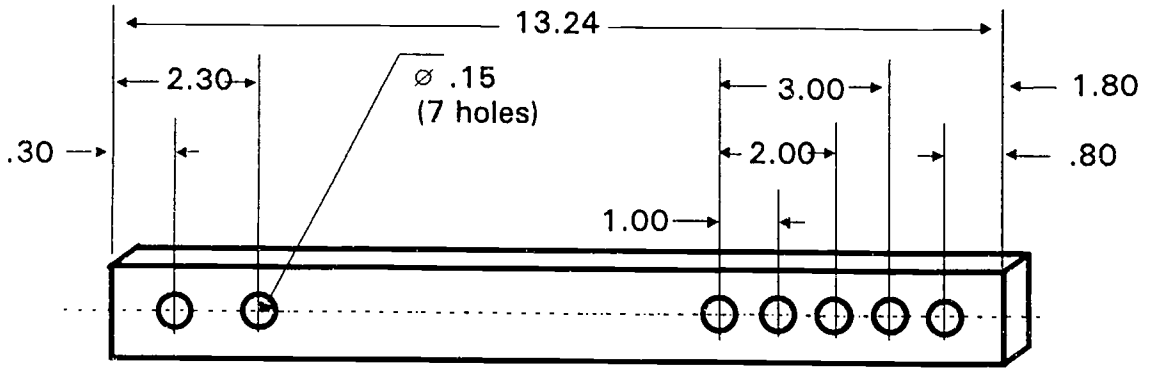
21. What is the overall length of the plate illustrated? (Ø .325 means diameter .325) All measurements are in inches.



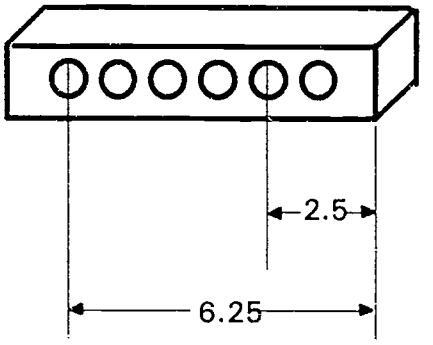
22. Find the missing dimension. The inside diameter is 4.023 inches.



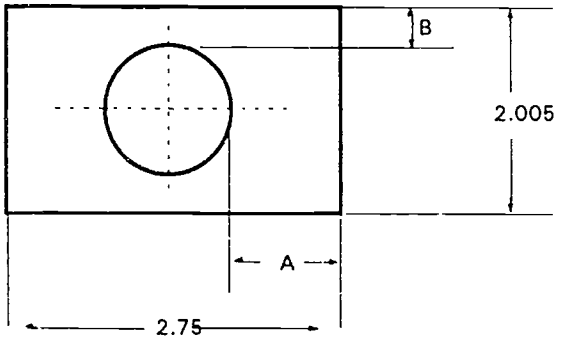
23. What is the spacing of the holes from center to center on the left side? on the right side? All measurements are in inches.



24. What is the spacing of the holes from center to center? (The holes are evenly spaced.)



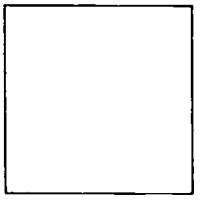
25. Find the missing dimensions. The hole is placed in the center of the plate. The radius of the hole is .56 inches.

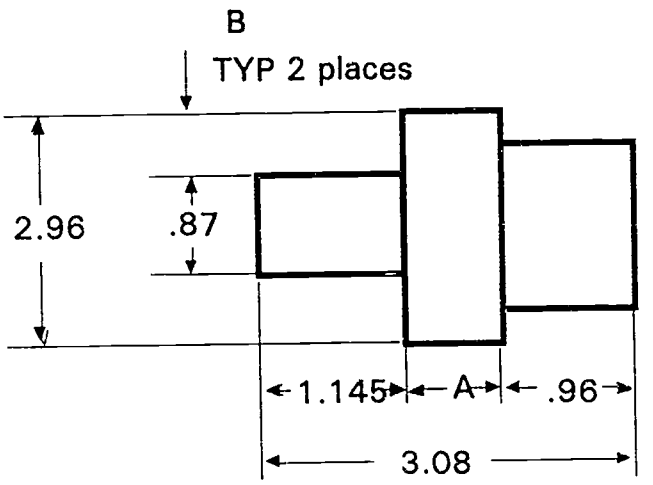


26. The diameter of a circle is .67 inches. What is its radius?

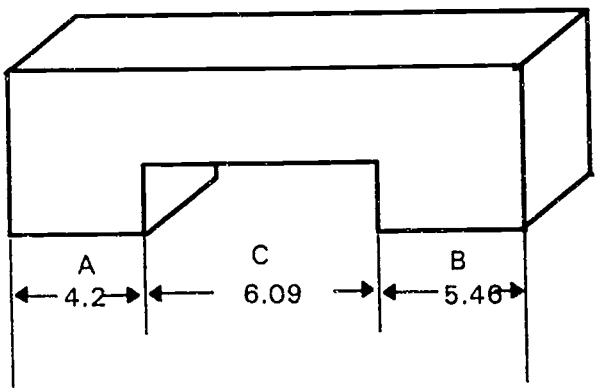
The radius of a circle is 2.39 inches. What is its diameter?

27. What is the total length of this punch in inches?





29. A piece is cut to the dimensions shown. Has it been cut to within the specifications ?



Specifications on the blueprint:

A = 4.21 ± .02

B = 5.38 ± .02

Overall length = 15.74 ± .02

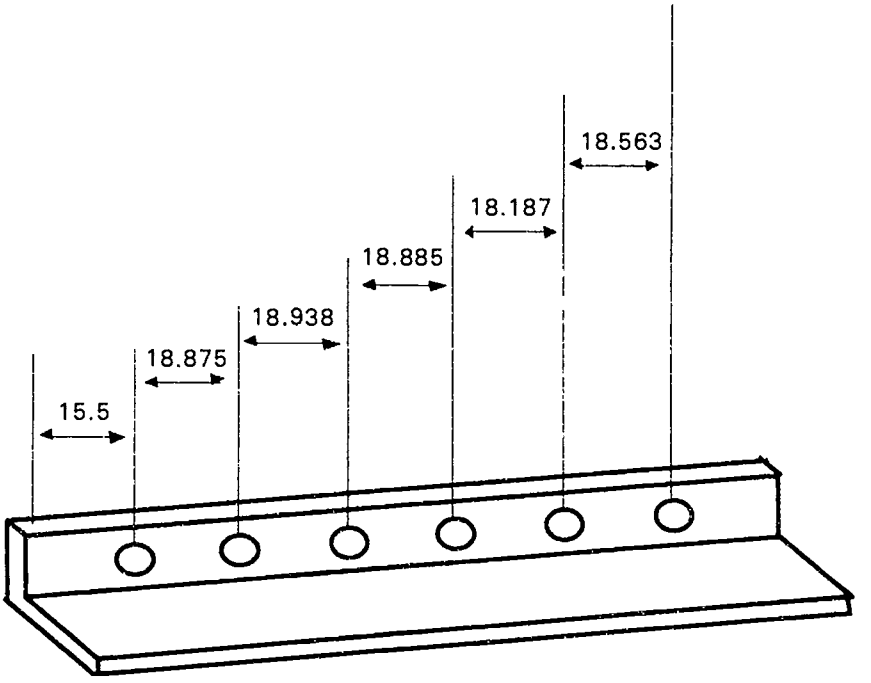
30. Washers are to be manufactured to the following thickness: .275 ± 0.002 An inspector measures and records the following thicknesses for six washers.

0.2702 0.278 0.276

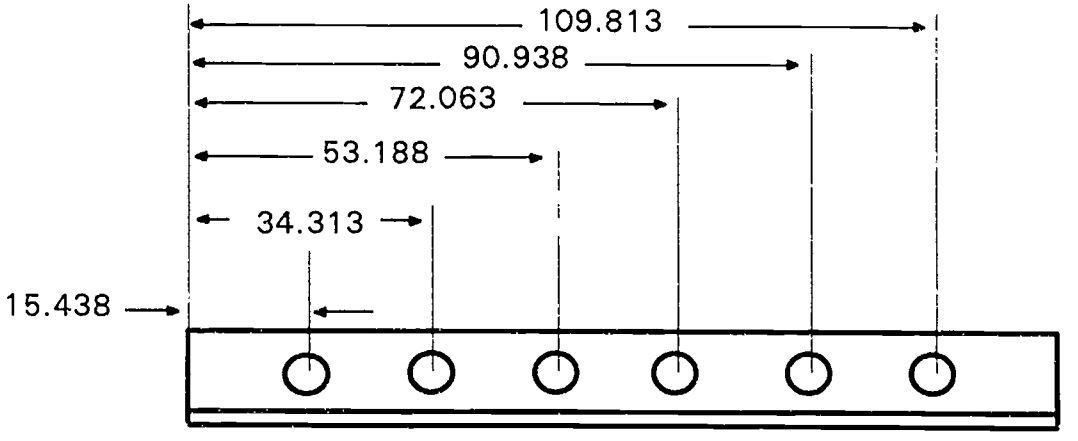
0.27 0.274 0.275

Which ones are defective?

31. The drawing below gives the actual locations of six holes drilled in a length of angle iron.



The blueprint is shown below. The tolerance for all measurements is ±.125 inches. Find the upper and lower limit for each dimension on the blueprint below. Compare these limits with the measurements given above. Which holes are drilled incorrectly?



Linear Measurement

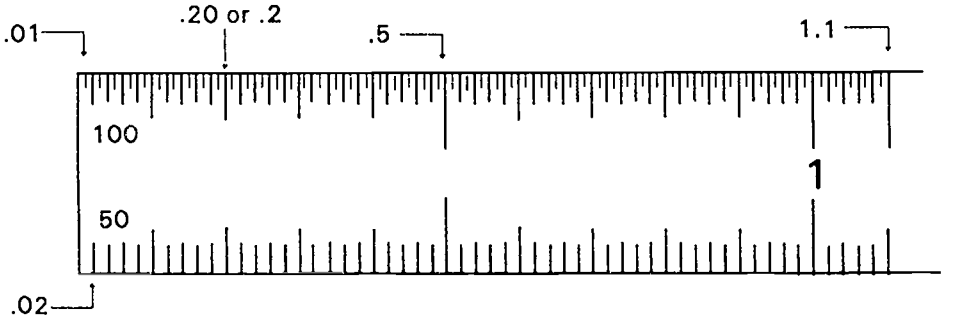
A. Steel Rule (English)

- read measurements and measure lengths on decimal-inch steel rules

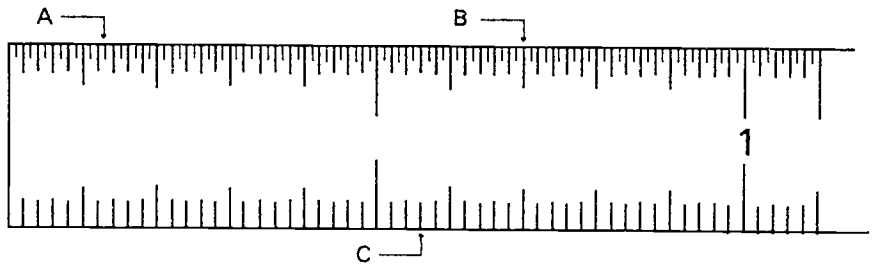
Steel rules (or tapes) are widely used for applications which do not require a high degree of precision. The steel rule is often the most practical measuring instrument to use for checking dimensions where stock allowances for finishing are provided. Steel rules are also used for locating roughing cuts on machined pieces and for determining the approximate locations of parts for machine setups. Steel rules used in the machine shop are generally six inches long.

Reading Decimal-Inch Rules

An enlarged decimal-inch rule is shown. The top scale is graduated in hundredths of an inch (0.01"). The bottom scale is graduated in fiftieths of an inch (0.02"). On the top scale there are 100 divisions per inch.
On the bottom scale there are fifty divisions per inch. The longer lines represent tenths.



NOTE: Two hundredths = one fiftieth or $\frac{2}{100} = \frac{1}{50}$ or .02 = one fiftieth



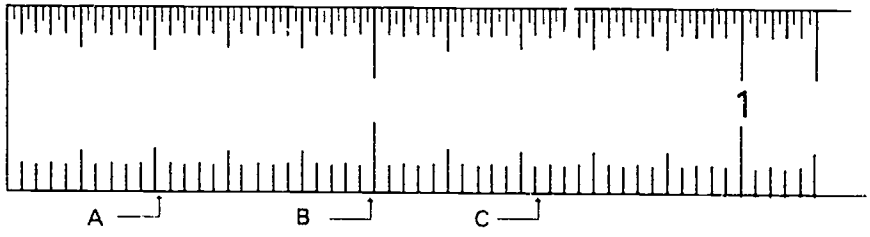
e.g. Read the following measurements on the enlarged decimal-inch rule shown above:

length A: 0.13"

length B: 0.70" = .7"

length C: $\frac{28}{50}$ = .56"

Often the edge of an object being measured does not fall exactly on a rule graduation. In these cases, read the measurement to the nearer rule graduation.



e.g. Read the following measurements, to the nearer graduation, on the enlarged decimal-inch rule shown:

A = .2"

B = .5"

C = .72"

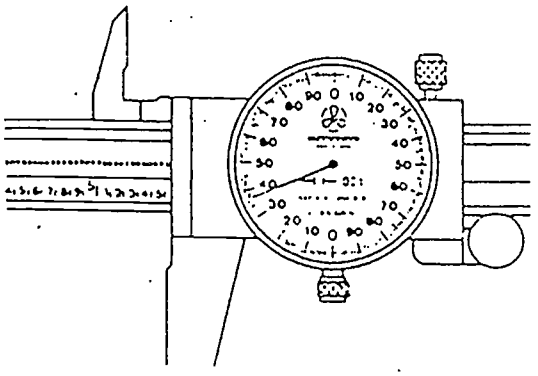
B. Dial Calipers (English)

- read and set given measurements on a decimal-inch dial caliper

Decimal-inch dial calipers are used in machine shop applications when the degree of precision to thousandths of an inch is adequate. They are used for measuring lengths of parts, distances between holes, and both inside and outside diameters of cylinders.

Dial Caliper

The basic parts of a dial caliper are a main scale which is similar to a steel rule with a fixed jaw and a sliding jaw with a dial scale. The dial scale slides parallel to the main scale and provides a degree of precision to 0.001". A dial caliper which is commonly used in machine shops is shown.



Reading a Measurement on a Decimal-Inch Dial Caliper

To read a measurement on a decimal-inch dial caliper,
(1) read the number of 1" graduations and the 0.1" graduations on the main scale,
(2) read the number on the dial indicating the 0.001" graduation, and
(3) add the numbers together to obtain the length.

e.g. to read the measurement on the dial caliper shown

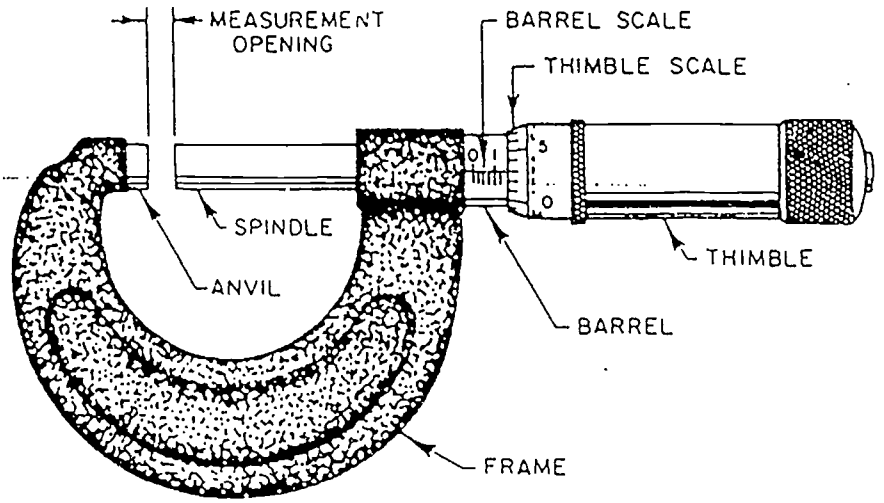
- ◊ there is 5" plus 0.5" on the main scale
- ◊ there is 0.037" on the dial
- ◊ so, add: 5.0" + 0.5" + 0.037" = 5.537"

C. English Micrometer
- read given measurements on the barrel and thimble scales of 0.001-inch micrometers

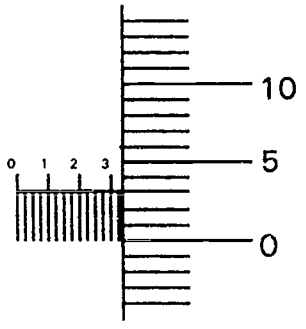
Micrometers are basic measuring instruments used by machinists in the processing and checking of parts. Outside micrometers are used to measure dimensions between parallel surfaces of parts and outside diameters of cylinders.

The 0.001-Inch Micrometer

The 0.001-inch micrometer is shown with its principal parts labeled.



Reading a 0.001-Inch Micrometer



e.g. read the micrometer setting shown

- ◊ observe the greatest 0.100-inch division on the barrel scale, (three 0.100" = 0.300")
- ◊ observe the number of 0.025-inch divisions between the 0.300-inch mark and the thimble, (one 0.025" = 0.025")
- ◊ add the thimble scale reading that coincides with the horizontal line on the barrel side, (three 0.001" = 0.003")
- ◊ micrometer reading:
  0.300" + 0.025" + 0.003" = 0.328"

D. Degree of Precision

- determine the degree of precision of commonly used measuring instruments

The degree of precision specified for a particular machining operation dictates the type of machine, the machine setup, and the measuring instrument used for that operation. Since the exact length of an object cannot be measured, by increasing the number of graduations on a measuring instrument, the degree of precision is increased.

The precision of measurement depends on the measuring instrument used. The degree of precision of a measuring instrument depends on the smallest graduated unit of the instrument.

Limitations of Measuring Instruments

Following are the limitations on the degree of precision possible of some measuring instruments:

Steel rule (decimal inch)
0.01" or .02"(depending on the smallest gradation)

Micrometers: 0.001" (decimal inch)

Dial calipers: 0.001" (decimal inch)

Degree of Precision of Numbers

The degree of precision of a number depends upon the unit of measurement. The degree of precision of a number increases as the number of decimal places increases.

e.g. degree of precision of:	to the nearest:
2"	inch
2.0"	tenth of an inch
2.00"	hundredth of an inch
2.000"	thousandth of an inch

E. Units of Measure (English)

- express an English unit of measure in larger or small units of measure

The ability to measure with tools and instruments and to compute measurements is a basic requirement in the machine trades. Presently, the United States uses both the English and the Metric systems of measure. Although these systems include all types of measure (length, area, volume, capacity), the machine trades use length measure most often.

English Units of Linear Measurement

1 yard (yd.) = 3 feet (ft.)
1 yard (yd.) = 36 inches (in.)
1 foot (ft.) = 12 inches (in.)

Expressing English Units of Measure as Smaller/Larger Units

To express a larger unit of length as a smaller unit of length, multiply the given length by the number of smaller units contained in one of the larger units.

e.g. express 2.5 feet as inches

since there are 12 inches in 1 foot,

multiply 2.5 by 12

2.5 x 12 = 30

so 2.5 ft = 30 in

To express a smaller unit of length as a larger unit of length, divide the given length by the number of smaller units contained in one of the larger units.

e.g. express 67 inches as feet

since there are 12 inches in 1 foot,

divide 67 by 12

$67 \div 12 = 5.583$

so 67 in. = 5.583 ft.

or $12\overline{)67}$ $\begin{matrix}5\\ \\ \end{matrix}$ remainder 7

so 67 inches = 5 feet 7 inches

Alternate Method

e.g. Express 2.5 feet as inches

Use the chart given above to write a conversion factor:

$$\frac{12 \text{ inches}}{1 \text{ foot}} \text{ or } \frac{1 \text{ foot}}{12 \text{ inches}}$$

Multiply:

Correct: $\frac{2.5 \text{ ft.}}{1} \times \frac{12 \text{ in.}}{1 \text{ ft.}} = 30 \text{ in}$

(NOTE: $\frac{\text{ft}}{\text{ft}} = 1$ leaving inches as the units)

Incorrect: $\frac{2.5 \text{ ft.}}{1} \times \frac{1 \text{ ft.}}{12 \text{ in.}}$??

The placement of the units will tell you if your calculation is done correctly.

BASIC BLUEPRINT READING ◆ PROBLEM SET 3

Linear Measurement

A. Units of Measure

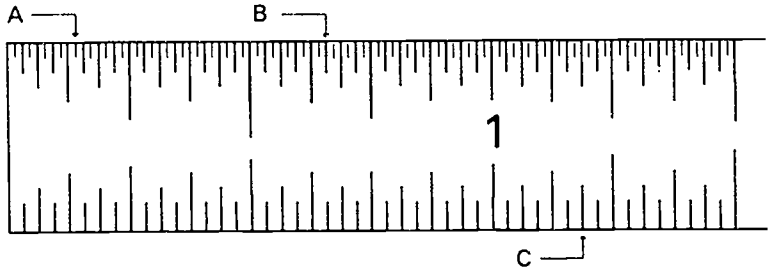
1. Express the English units of measure in larger or smaller unit of length.

3 ft 7 in = _____ in. 6 yd 4 ft = _____ ft.

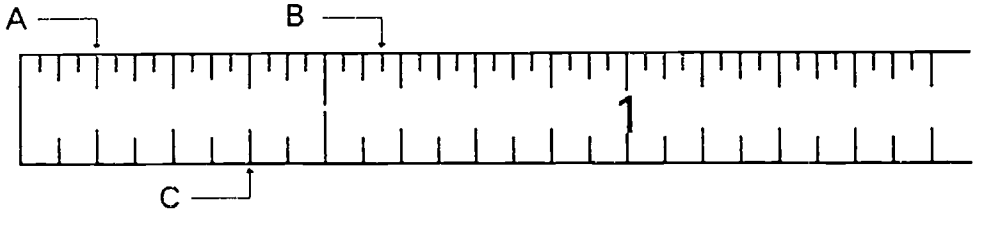
7 yd 3 ft 6 in = _____ in. 8 ft = _____ in.

5 yd = _____ ft.

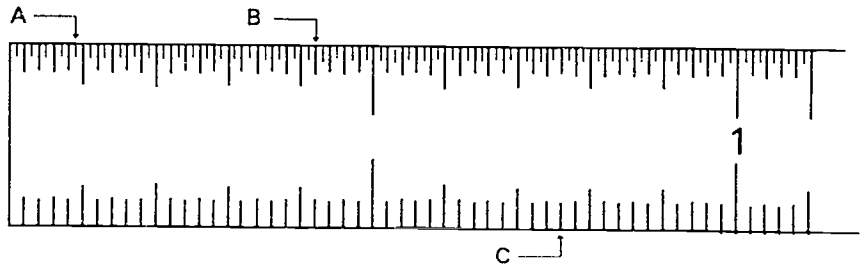
2. Determine the length of each measurement.



3. Determine the length of each measurement.



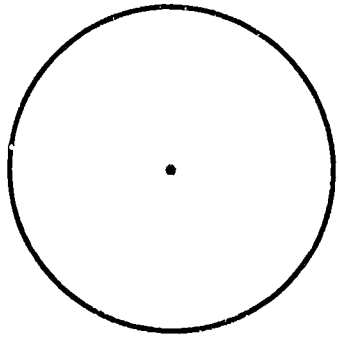
4. Determine the length of each measurement.



5. Measure the length of each line first using a steel rule and then the dial caliper. What is the precision of each measuring instrument? Which is more accurate in this situation?

	ruler	dial caliper
a.	_____	_____
b.	_____	_____
c.	_____	_____
d.	_____	_____

6. Measure the diameter of the circle below. What is its radius? With what precision are you making this measurement?



7. What is the largest measurement you can make with your:

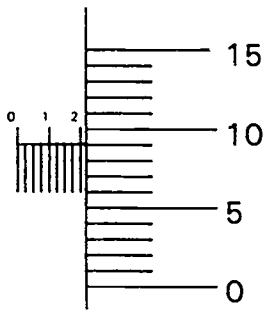
   a. steel rule

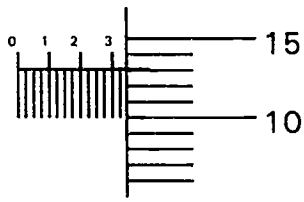
   b. dial caliper

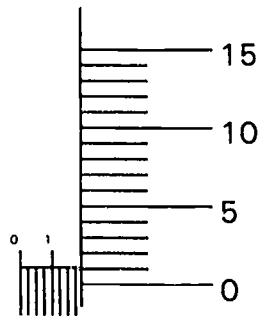
   c. micrometer

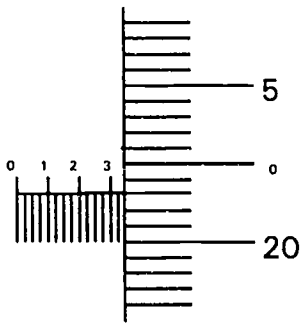
8. What is the difference between tolerance and precision?

9. Determine the value of each micrometer reading.

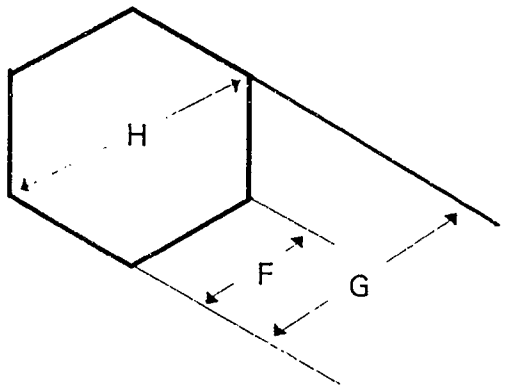


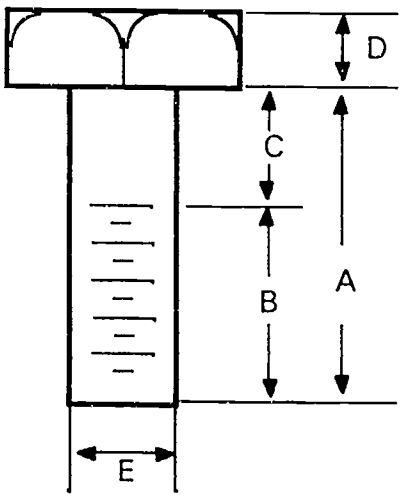






10. Use the bolt given to you by your instructor





Find all the measurements indicated.

A. _____

B. _____

C. _____

D. _____

E. _____

F. _____

G. _____

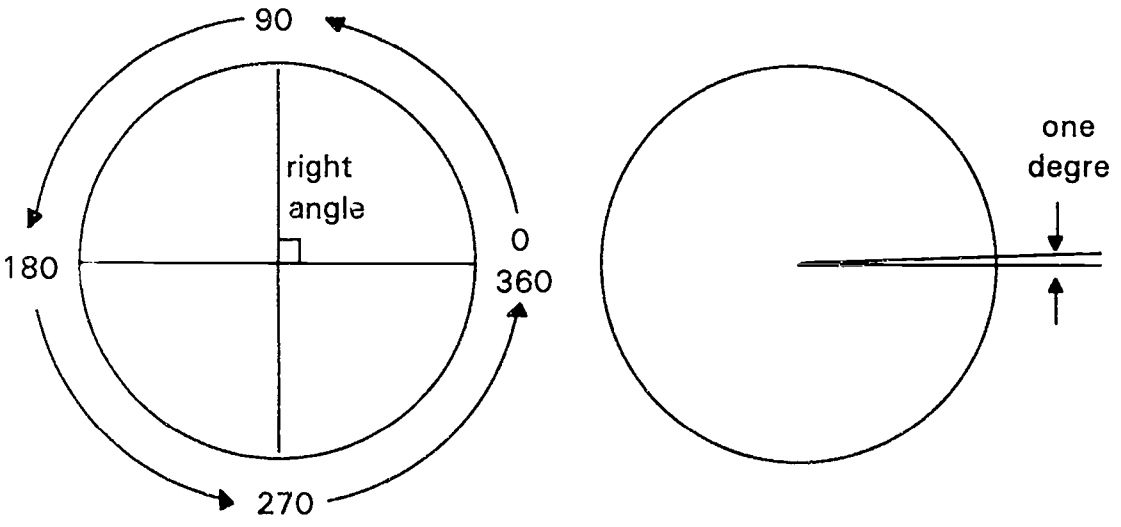
H. _____

Angular Measurement

A. Basic Skills
- measure angles using degrees
- measure internal and external angles

The fundamental principles of geometry generally applied to machine shop problems are those used to make the calculations required for machining parts from engineering drawings. An engineering drawing is an example of applied geometry.

Units of Angular Measure



1 circle = 360°

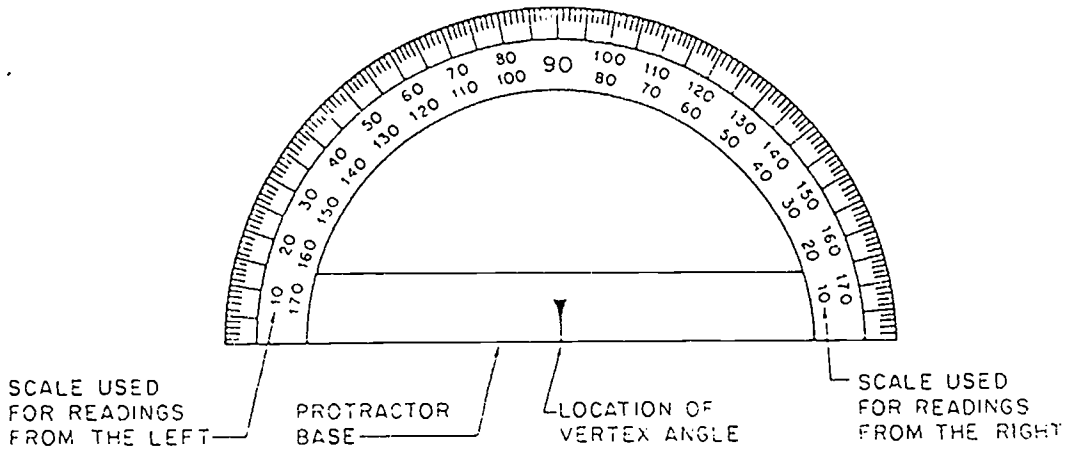
$\frac{1}{2}$ circle = 180°

B. Protractors (Simple and Vernier)

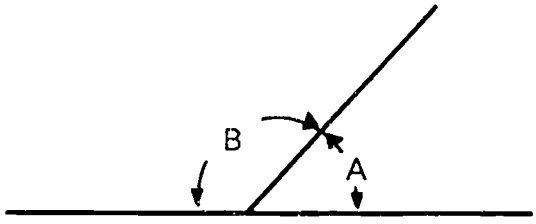
- measure angles with a simple protractor
- compute complements and supplements of angles

Protractors are used for measuring and laying out angles. Although all protractors are basically the same, different types are available for different uses and degrees of precision required.

Simple Protractor

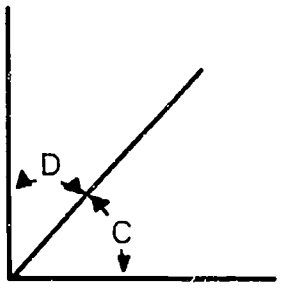


Complements and Supplements of Scale Readings



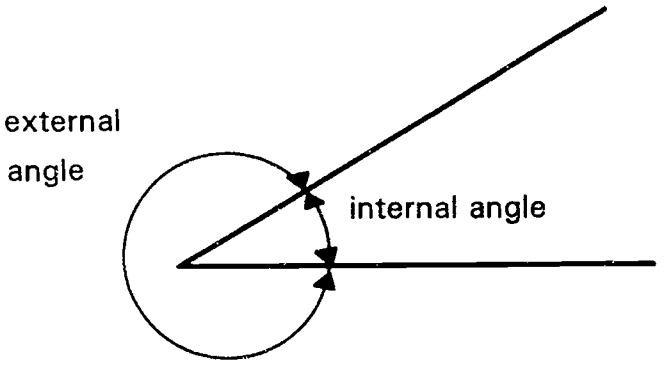
Supplementary angles = 180

Internal and External Angles



Complementary angles = 90

Internal and External Angles



internal angle + external angle = 360°

BASIC BLUEPRINT READING ◆ PROBLEM SET 4

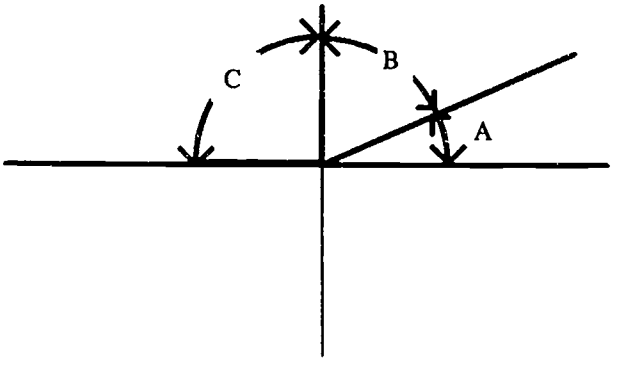
Angular Measurement

In the English systems, angles are measured in degrees.

1. How many degrees are there is a right angle? How many degrees are there is two right angles? How many 60-degree angles are there in two right angles?

_____ _____ _____

2. From the following diagram, determine the value of angle B if angle A is 30 degrees. Angle C is 90 degrees.

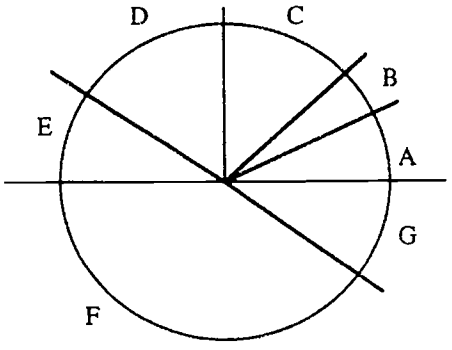


A = 30°

B = _____

C = _____

3. In the following circle; angle A = 30 degrees, angle B = 20 degrees, angle D = 65 degrees, and angle F = 118 degrees.



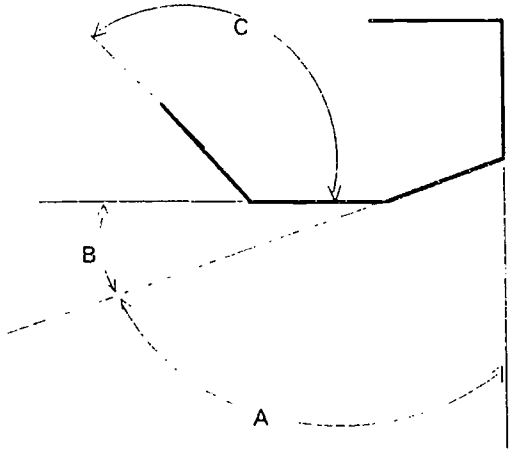
What is the sum of angles A and B? Angles A, B, and C total 90 degrees.
Find the value of angel C.
What is the sum of angles A, B, C, and D?
Find the value of angle E.
What is the sum of angles A, B, C, D, E, and F? Find angle G.

A + B = _____ A + B + C + D + E + F = _____

C = _____ A + B + C + D = _____

E = _____ G = _____

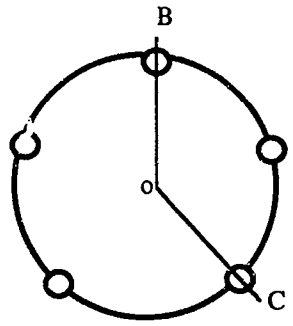
4. In the following diagram, if angle A is 78 degrees and angle B is 30 degrees and angle C is 135 calculate all the internal angles.



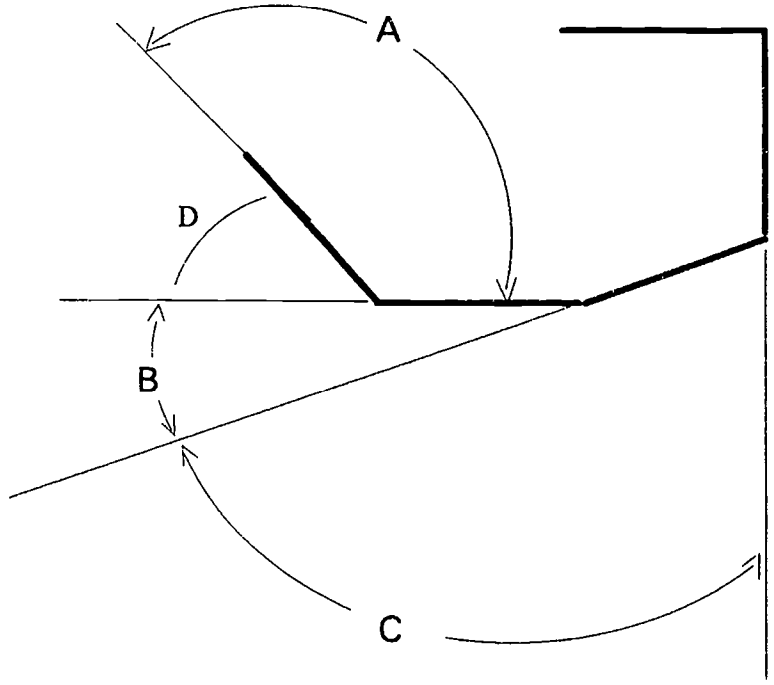
C = _____

5. A layout of five holes equally spaced on a 10-inch circle is shown. What angle is formed by connecting the centers of holes B and C with the center?

_____



6. Using a simple protractor, measure angles A, B, C, and D.



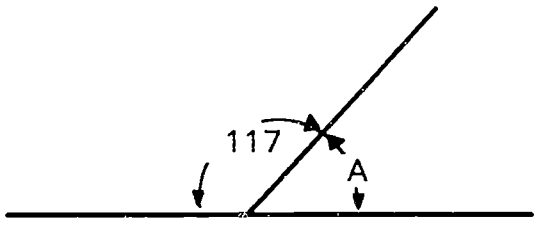
A = _____ B = _____

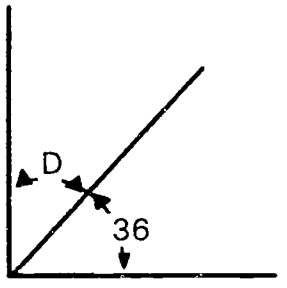
C = _____ D = _____

Calculate angle E and F.

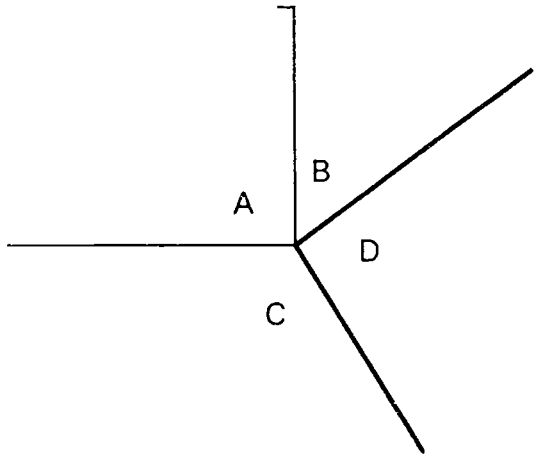
E = _____ F = _____

7. Find Angle A and angle D.





8. Find angle D if angle A is a right angle, angle B = 35 ° and angle C = 110°.



9. What is the internal angle with an external angular measurement of 275°?

_____

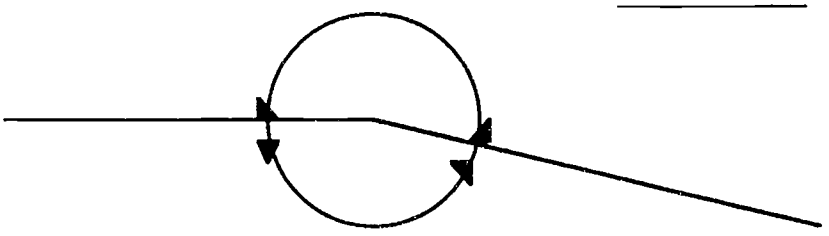
10. What is the external angle with an internal angular measurement of 35°?

_____

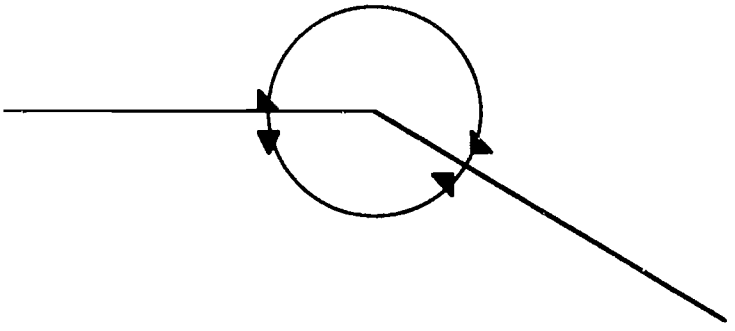
ANGULAR MEASUREMENT

Indicate the internal and external angles and measure.

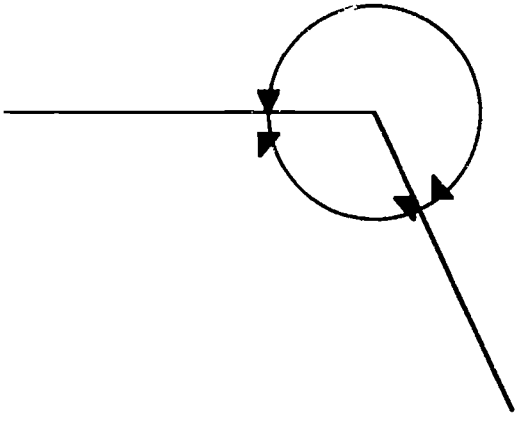
	Internal	External
a.	_____	_____



b.	_____	_____

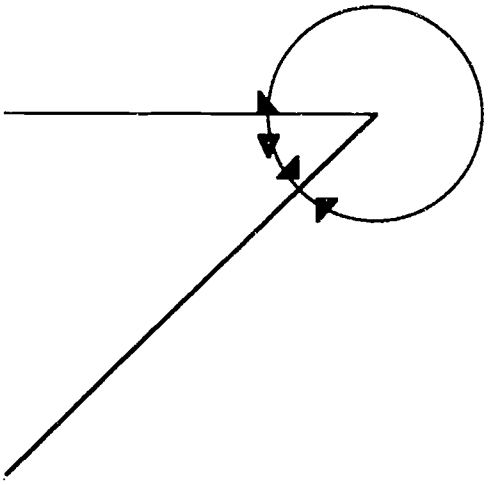


c.	_____	_____

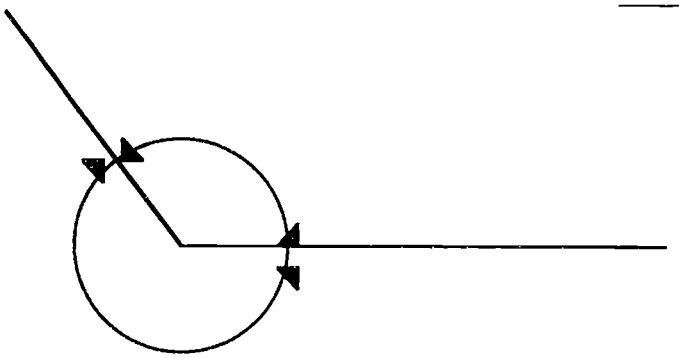


	Internal	External
d.	_____	_____
e.	_____	_____
f.	_____	_____
g.	_____	_____
h.	_____	_____

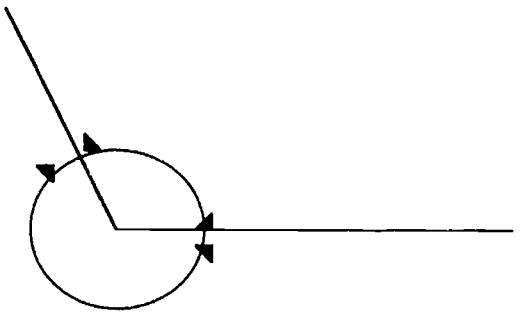
d.



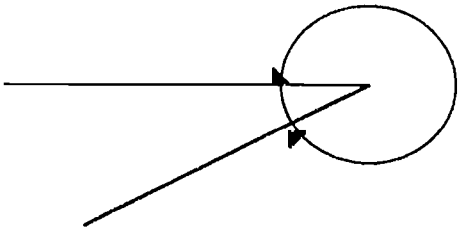
e.



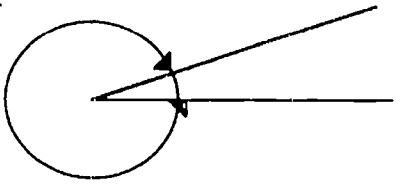
f.



g.



h.



h.

77

CIRCULAR FUNCTIONS

Name _____

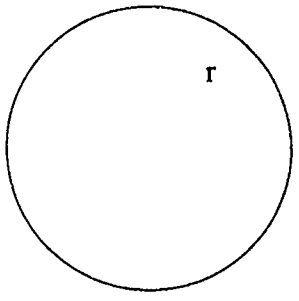
1. TP1" means _____

_____

2.

(Circumference - # of Turns)

3.



Circular Functions

Area $= \frac{\Pi D^2}{4}$

$= \Pi r^2$

$= .7854D^2$

Circumference $= \Pi D$

Radius $= \frac{1}{2}$ Dia.

Diameter = Longest line inside circle

4. Measure diameter of bolt and calculate circumference.

(a) $\frac{5}{16}$"$\varnothing$ = _____ Π = _____"

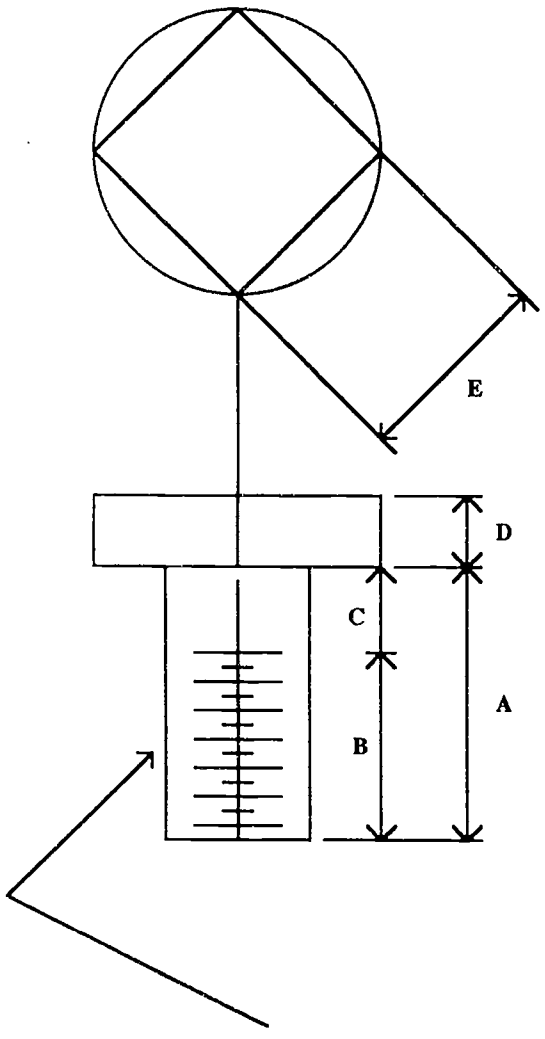
(b) $\frac{3}{8}$"$\varnothing$ = _____ Π = _____"

(c) $\frac{7}{16}$"$\varnothing$ = _____ Π = _____"

(d) $\frac{1}{2}$"$\varnothing$ = _____ Π = _____"

(e) $\frac{9}{16}$"$\varnothing$ = _____ Π = _____"

BOLT MEASURING EXERCISE



Bolt	A	B	C	D	E
1					
2					
3					
4					
5					

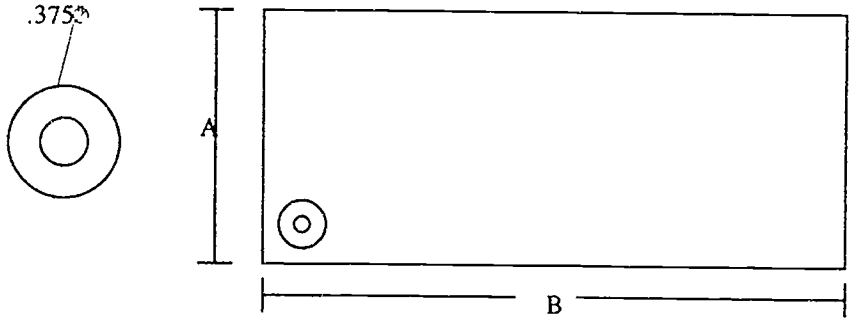
Dia.. = _____

TPI. = _____

Matl. = _____

SKETCH

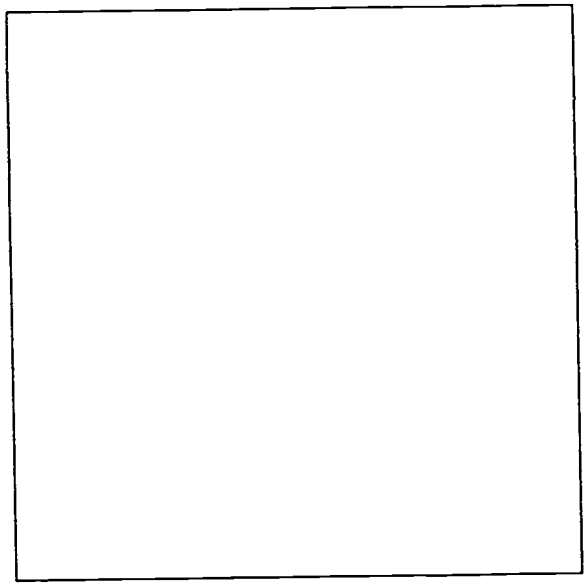
1. How many washers of size indicated can be produced from a sheet of dimensions shown? (Sketch of your layout below)



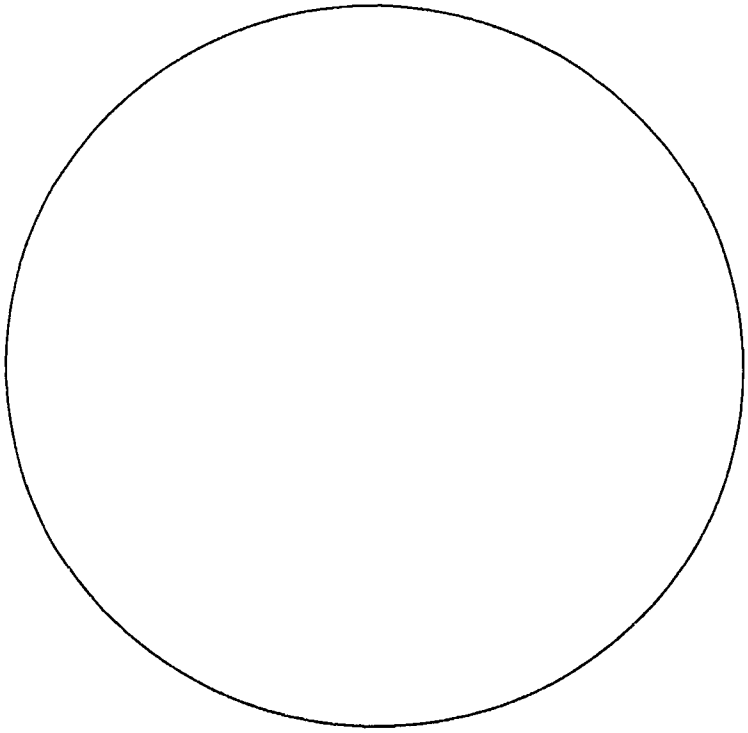
A x B	2' x 4'	3' x 5'	30" x 50"	1' x 2'	18" x 24"	32" x 48"

BASIC DRAWINGS

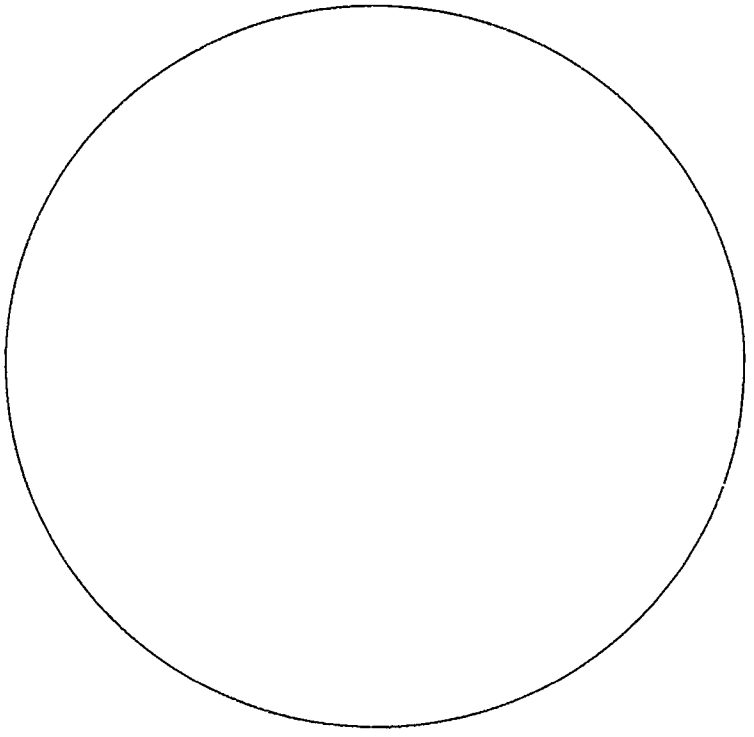
1. Inscribe a circle in the square.



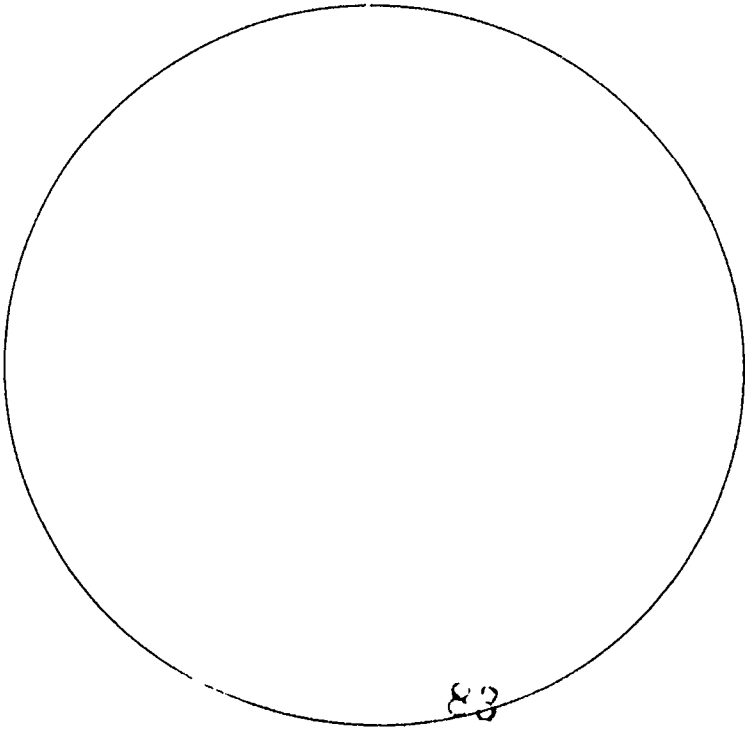
2. Inscribe a square in the given circle.



3. Draw a sector with an internal angle of 39°, 45° and 75°.



4. Draw a hexagon and label central angles.



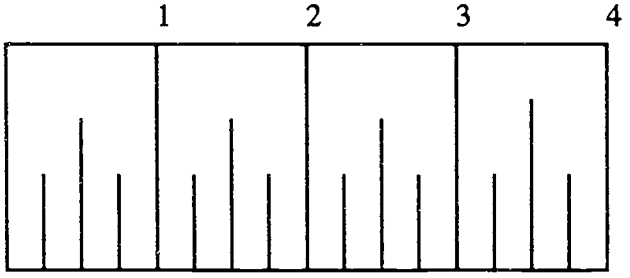
UNDERSTANDING & READING DRAWINGS

This section will include company specific blueprint drawings and explanations relevant for employees. Review of the math concepts should be stressed. Provide time for manipulation of the tools, and explanations of the math involved.

BASIC BLUEPRINT READING ◆ POST-TEST

Name: _____

1.



a. Divide first inch into $\frac{1"}{4}$ units

b. Divide second inch into $\frac{1"}{8}$ units

c. Divide third inch into $\frac{1"}{16}$ units

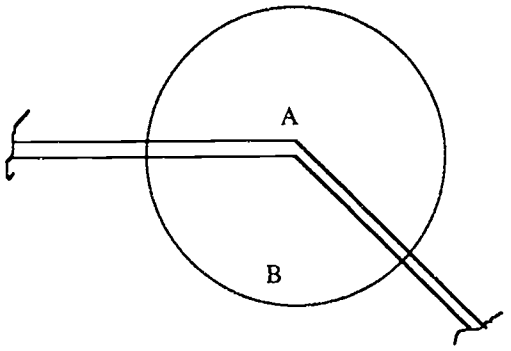
d. Divide fourth inch into $\frac{1"}{32}$ units

2. A micrometer spindle is advanced _____" on each full turn.

3. .032" + 003 = _____"

- 002 = _____"

4.

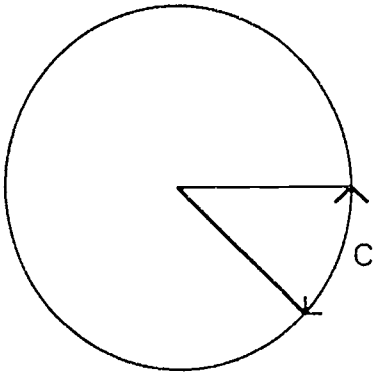


Angle A = _____°

Angle B = _____°

The sum of all central angles = _____°.

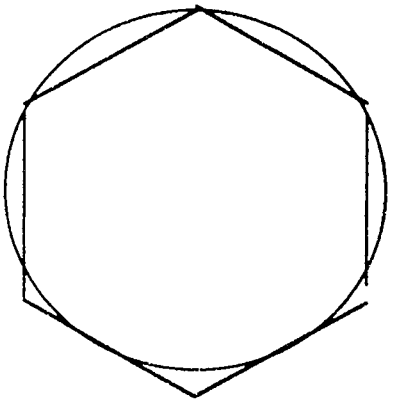
5.

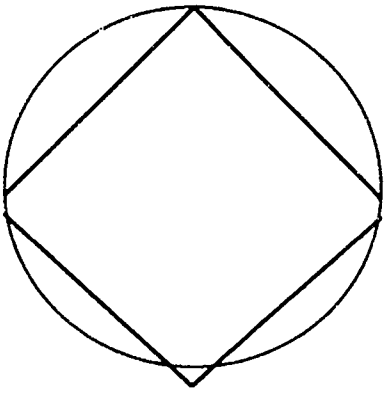


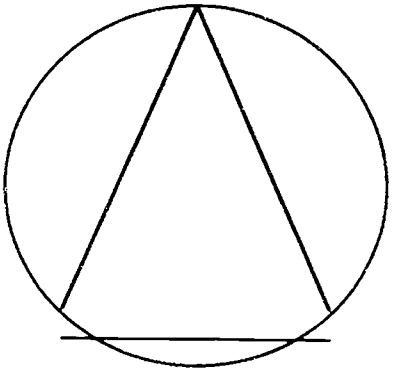
The last piece of a pie is equal to $\frac{1}{7}$th of the total. What is the angle indicated?

C = _____°

6. Describe figures shown (on reverse side of this sheet).







a. _____ b. _____ c. _____

7. Express fractions in lowest terms.

a. $\frac{12}{28}$ = _____ d. $\frac{20}{25}$ = _____

b. $\frac{13}{39}$ = _____ e. $\frac{12}{36}$ = _____

c. $\frac{9}{18}$ = _____ f. $\frac{112}{128}$ = _____

8. Express mixed numbers as improper fractions.

a. $6\frac{3}{4}$ = _____ d. $10\frac{3}{5}$ = _____

b. $2\frac{1}{8}$ = _____ e. $6\frac{7}{8}$ = _____

c. $5\frac{2}{3}$ = _____ f. $4\frac{1}{2}$ = _____

9. Perform the indicated operation.

a. $\frac{2}{3} + \frac{1}{6} =$ _____

b. $\frac{1}{2} + \frac{3}{8} =$ _____

c. $\frac{7}{8} + \frac{5}{16} =$ _____

d. $\frac{3}{16} + \frac{1}{8} + \frac{1}{3} + \frac{1}{4} =$ _____

e. $\frac{1}{3} + \frac{1}{6} + \frac{3}{16} + \frac{1}{12} =$ _____

f. $\frac{1}{8} + \frac{2}{3} =$ _____

10. A screw is $3\frac{1}{2}$ inches long and has 56 threads. What is its TPI?

_____

11. Sheets of steel are stacked to a height of 3" on a pallet. The metal sheets are .025" thick. If each sheet weighs 2.3 lbs, how much weight is on the pallet?

_____ lbs.