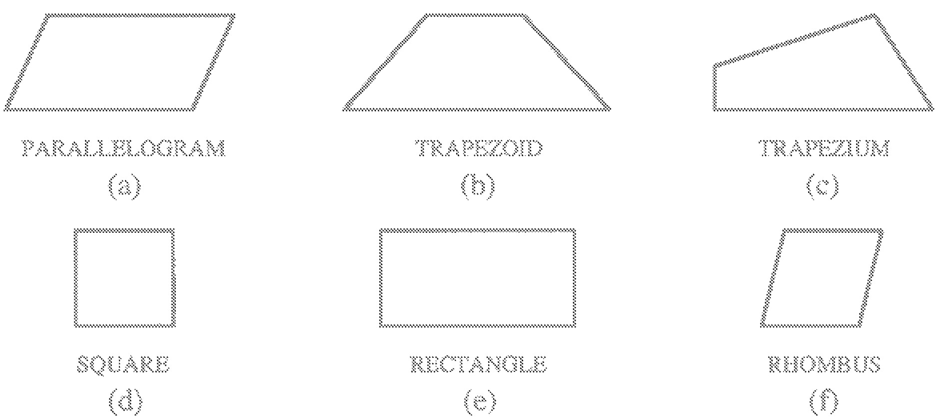
STUDENT'S GUIDE

Fractions, Decimals, Percentages and Angles II

A Curriculum for Members of The International Brotherhood of Painters and Allied Trades



ADDITIONAL POLYGONS

International Brotherhood
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Joint Apprenticeship and Training Fund
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A Curriculum for the
members of the
International Brotherhood
of Painters and Allied Trades AFL-CIO

The IBPAT JATF Educational Program, which involves this series of instructional materials in conjunction with classroom or correspondence-type instruction and on-the-job training, is provided to help maintain a constant supply of qualified workers for the industry. Everyone who enters the trade makes a definite commitment to themselves as well as to the employer. This includes a commitment to work diligently, to learn new techniques as well as improve on those already learned, to maintain an attitude which promotes learning, and to exercise a high degree of maturity in all matters related to the job.

These instructional materials are provided as a supplement to the on-the-job training everyone receives while performing their job. Every journeyman and apprentice must seek to learn from any source at their disposal in a continuing effort to enhance and upgrade their skills. The Industry is in a constant state of change and only through efficient and continued education will our trades remain state-of-the-art.

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by

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OBJECTIVES:

At the completion of this module each student should be able to:

- Describe how to add, subtract, multiply, and divide decimal fractions.
- Have a basic understanding of percentages.
- Describe and\or identify basic angles, polygons, and triangles.
- Have a basic understanding of the Pythagorean Theorem.
- Describe how to accurately measure angles with a protractor.

NOTES

Today's union craftperson must demonstrate a wide range of skills including an excellent mechanical aptitude and strong leadership abilities. Another very important skill deals with the ability to solve basic mathematical problems that may be encountered during the measurement, layout, cutting of glass, aluminum, carpet, tile and wallboard, etc.

The emphasis in previous math topics was on whole numbers or "integers." This topic, along with "FRACTIONS, DECIMALS, PERCENTAGES, AND ANGLES - PART 1," deals with numbers that are not whole numbers.

DECIMALS

Decimals play a daily role in most of our lives; especially in relation to money. Other examples might include baseball batting averages (.283) as well as distances between cities (38.7 miles).

Decimals are used to describe the thickness of sheet metal, the thickness of painted coatings (Class I is .7 mills.), and the thickness of PVB interlayers in laminated glass.

Introducing Decimals

In the "Basic Mathematics/Measurement" topic, it was explained that every digit or number has a place value. This place value is always 10 times greater than the value of the digit immediately to its right and one tenth (1/10) of the value of the digit immediately to its left (see Figure 1).

The columns to the left of the decimal point represent whole numbers while the place values right of the decimal point represent fractional values. The decimal point (.) is used to separate whole numbers from the fractional values and is read using the word "and".

10,000	1,000	100	10	1	$\frac{1}{10}$	$\frac{1}{100}$	$\frac{1}{1,000}$	$\frac{1}{10,000}$
Ten Thousands	Thousands	Hundreds	Tens	Ones	Tenths	Hundredths	Thousandths	Ten Thousandths

Each Place has a value one-tenth of that to the left.
Each place has a value ten times the place to the right.

Figure 1—PLACE VALUES

For example, if you look at the number "234.875" in Figure 1, you can see that 234 is a whole number while .875 is a fractional value. 234.875 is called a mixed decimal because it has a whole number and a fractional value.

.8 is in the 1/10 column. This is a one-place decimal. It is read as 8 tenths (8/10).

The column to the right of the tenths column is the hundredths column. .87 would be read as 87 hundredths (87/100). This is a two place decimal.

Continuing to the right, .875 would be read as 875 thousandths (875/1000). This is a three place decimal.

The farther a number moves to the left of the decimal, the larger the number. The farther a number moves to the right, the smaller its value.

PRACTICE PROBLEMS

PRACTICE PROBLEMS

Write each in decimal form:

1. 6/10 =

2. 3/100 =

3. 1/10 =

4. 17/100 =

5. 2/1000 =

Write each in fractional form.

6. .5 =

7. .25 =

8. .08 =

9. .032 =

10. .001 =

Zeros and Decimals

Zeros play an important role when used between a decimal point and a number (.06). The zero helps put the digit or digits in their proper place. Without zeros, each number would look like .6, for example, and each would be read as a tenths.

Zeros are also used when comparing decimals. For example, if you were to look at .5 and .505, how would you determine which is the smaller of the two?

In this example, .5 has a denominator of 10 while .505 has a denominator of 1000. In order to compare these two decimals they must be made into equivalent fractions as shown in Figure 2.

Problem	Step 1	Step 2
Compare .5 And .505	$.5 = .500 = \frac{500}{1,000}$ $.505 = \frac{505}{1,000}$	$\frac{500}{1,000} < \frac{505}{1,000}$ or $.500 < .505$ or .5 .505
	.505 is a three place decimal. Change .5 to a three place decimal by adding two zeros to the right of the decimal: .5 = .500 Change both decimals to fractions.	Compare the fractions.
	Thus: $.5 < .505$	

Figure 2—COMPARING DECIMALS

PRACTICE PROBLEMS

Change each of the following decimals to equivalent decimals expressed in thousandths:

11. .43 =

12. .04 =

13. .1 =

14. .024 =

Select the larger of the two numbers:

15. .82 or .8 =

16. .95 or .92 =

17. .71 or .69 =

18. .004 or .04 =

Arrange the numbers in order of size (smallest first):

19. .077, .07, .7 =

20. 3.01, 3.001, 3.1 =

Adding Decimals

When adding decimal fractions, always place the decimals in vertical columns with each decimal point properly lined up so that the place values can be accurately added. Add the numbers as you would whole numbers (see Figure 3). Be sure to include the zero if necessary.

The operation is the same when adding mixed decimals (see Figure 4). Place the mixed decimals in vertical columns being careful that the decimals are properly lined up. Add the numbers.

Problem	Step 1	Step 2	Step 3
.3205 + .27 + .121 =	.3205 .27 + .121	.3205 .27 + .121 .7115	.3205 .27 + .121 .7115
	Line up the decimals and place the decimal point in the answer.	Add up the numbers. You can annex zeros to the right of each number without changing its value. Thus: .27 = .2700 .121 = .1210	OR since the zeros are understood to be there, just add the numbers without annexing the zeros
Thus: .3205 + .27 + .121 = .7115			

Figure 3—ADDING DECIMALS

Problem	Step 1	Step 2
151.2 + 87.3 + 43.6 =	151.2 87.3 + 43.6	151.2 87.3 + 43.6 282.1
	Line up the addends and place the decimal point in the answer.	Add up the numbers.
Thus: 151.2 mi. + 87.3 mi. + 43.6 mi. = 282.1 mi.		

Figure 4—ADDING DECIMALS

Subtracting Decimals

To subtract decimal fractions they must, as in addition, be lined up by decimal points in vertical columns. Subtract the numbers as you would subtract whole numbers (see Figure 5).

Mixed decimals are subtracted in the same way as decimal fractions.

Problem	Step 1	Step 2
.025 - .019 =	.025 - .019	.025 - .019 .006
	Place the decimals in vertical columns, lining up the decimal points in the answer directly below the other decimal points.	Subtract the numbers. Be sure to include the zeros. (Remember: .006 is not equal to .6).
Thus: .025 - .019 = .006		

Figure 5—SUBTRACTING DECIMALS

PRACTICE PROBLEMS

21. .8 + .4 =

22. 3.56 + 4.73 =

23. 32.865 + 2.97 =

24. 52.986 + .06 =

25. .345 + .4 + .05 + 1.9 =

26. .8 - .2 =

27. 7.6 - 3 =

28. 91.3 - 73.9 =

29. 6.84 - .58 =

30. 6.51 - 2.47 =

Multiplying Decimals

The same process is used to multiply decimal fractions as that used to multiply whole numbers. The difference is that after the multiplying process is complete, the decimal point must be correctly placed in the answer. The correct placement of the decimal depends upon how many total decimal places are contained in the multiplication problem.

For example (see Figure 6), since 5.85 is a two place decimal in the problem 5.85 X 6, the decimal point in the answer will be placed two places from right to the left.

Problem	Step 1	Step 2
5.85 x 6	5.85 x 6 3510	5.85 x 6 35.10
	Multiply the numbers: 585 X 6 = 3510	5.85 has 2 decimal places. Place the decimal point in 3510 counting 2 places from right to left. Thus: 35.10 = 35.1
Thus: 5.85 in. X 6 = 35.1		

Figure 6— MULTIPLYING DECIMALS

When multiplying two decimal fractions that together contain four decimal places, the decimal point in the answer must be placed four places from right to left (see Figure 7).

When multiplying, the decimal points do not need to be lined up vertically as they do when subtracting or adding.

Problem	Step 1	Step 2
8.72 x 0.48	8.72 x 0.48 6972 3488 41856	8.72 x 0.48 6972 3488 4.1856
	Multiply the numbers:	Place the decimal point in the product, counting 4 places from the right. Place it between the "4" and the "1".
Thus: 0.48 x 8.72 = 4.1856		

Figure 7—MULTIPLYING TWO DECIMALS

Dividing Decimals

<u>Dividing Decimal Fractions by Whole Numbers</u>

Dividing decimal fractions by whole numbers is accomplished using the same division process as when dividing whole numbers. The decimal point is placed in the answer (or quotient) directly above the decimal point in the dividend (see Figure 8).

$4\overline{)2.8}$	$\begin{array}{r} 7 \\ 4\overline{)2.8} \end{array}$	$\begin{array}{r} .7 \\ 4\overline{)2.8} \end{array}$
	Divide: $28 \div 4 = 7$	Place the decimal point in the quotient (7) above the decimal point in the dividend.
Thus: $\begin{array}{r} .7 \\ 4\overline{)2.8} \end{array}$		

Figure 8—DIVIDING DECIMALS

When necessary, a zero is used to hold a place between the decimal point and the first digit in the quotient. Sometimes there may be more than one zero (see Figure 9).

Step 1	Step 2	Step 3
$5\overline{).025}$	$\begin{array}{r} 5 \\ 5\overline{).025} \end{array}$	$\begin{array}{r} .005 \\ 5\overline{).025} \end{array}$
	Divide: $25 \div 5 = 5$ Place the 5 in the quotient above the dividend.	Place the decimal point in the quotient above the decimal point in the dividend. Include two zeros between the decimal point and the 5 as place holders.
Thus: $\begin{array}{r} .005 \\ 5\overline{).025} \end{array}$		

Figure 9—USING A ZERO TO HOLD THE PLACE VALUE

Dividing Decimal Fractions by Decimal Fractions

When dividing decimal fractions, the divisor must be a whole number. To change a divisor to a whole number, the easiest method is to multiply it by 10, 100, 1000, etc. Both terms of the fraction (the divisor and the dividend) must be multiplied by the same number to maintain an equivalent fraction. After the divisor has been changed to a whole number, divide the whole number into the dividend (see Figure 10).

Step 1	Step 2	Step 3
$.04\overline{).008}$	$.04\overline{).00.8}$	$\begin{array}{r} .2 \\ 4\overline{).8} \end{array}$
	Multiply the divisor (.04) by 100 to make it a whole number: .04 x 100 = .04. = 4 Multiply the dividend (.008) also by 100: .008 x 100 = .00.8 = .8 Place a decimal point in the quotient.	Divide: .8 ÷ 4 = .2
Thus: .008 ÷ .04 = .2		

Figure 10—DIVIDING DECIMAL FRACTIONS BY A DECIMAL FRACTION

PRACTICE PROBLEMS

PRACTICE PROBLEMS

31. 3.53 X 2 =

32. .87 X .69 =

33. 9.02 X .38 =

34. .45 ÷ 5 =

35. .081 ÷9 =

PERCENTS

Percent is a way of expressing a fraction or a decimal. Percent, or its symbol "%", means hundredths.

Changing Percents to Decimals

To change a percent to a decimal, remove the percentage symbol and move the decimal point two places to the left. By moving the decimal two places to the left of the original number, you are actually dividing the number by 100. The digits or numbers don't change.

For example, 40% is equivalent to .40, 4% is equivalent to .04, and 3.2% is equivalent to .032 (see Figure 11).

Problem	Step 1	Step 2	Step 3
Change 45% to a decimal.	45% = 45.%	.45.%	.45
	Place the decimal point to the right of 45: 45.%	Divide by 100 by moving the decimal point 2 places to the left: .45. Omit the % sign.	

Figure 11—CHANGING PERCENTAGES TO DECIMALS

Changing Decimals to Percents

To change a decimal to a percent, multiply by 100 by moving the decimal point two places to the right and adding a percent sign (see Figure 12).

Problem	Step 1	Step 2
Change .62 to a percent.	.62 = 62.	62%
	Multiply the decimal by 100: .62. X 100 = 62	Affix the % sign.

Figure 12—CHANGING DECIMALS TO PERCENTS

Finding a Percent of a Number

To find the percent of a number, change the percent to a decimal and then multiply (see Figure 13).

Problem	Step 1	Step 2	Step 3
.25 *x* 80 =	.25% = .25	80 *x* .25 400 160 2000	80 *x* .25 400 160 20.00
	Divide by 100 by moving the decimal point two places to the left: .25. Omit the % sign.	Multiply.	Place the decimal point in the product, counting 2 places from the right as shown.
Thus: .25 X 80 = 20.00			

Figure 13—FINDING 25 PERCENT OF THE NUMBER 80

PRACTICE PROBLEMS

Change each of the following percents to decimals:

36. 75% =
37. 5% =
38. 125% =
39. 1.5% =
40. 80% =

Change each of the following decimals to percents:

41. .38 =
42. .375 =
43. 3.12 =
44. .050 =
45. .6 =

Find the answer:

46. 4% of 60 =
47. 125% of 20 =
48. 300% of 6 =
49. 40% of 65 =
50. 6.5% of $2.74 =

LENGTHS, ANGLES AND FLAT FIGURES

Lines are measured in linear units (units of length) such as inches, feet, yards, etc. (see Figure 14). Lines are lettered to distinguish them. For example, if one end is marked A and the other is marked B, the line is called line AB or BA.

(a) (b) (c)

Figure 14
LENGTHS, ANGLES AND FLAT FIGURES

A curved line is one that is continually changing its direction.

A broken line is one made up of several straight lines.

A straight line is one that has the same direction throughout its length. It is the shortest distance between two points.

If two straight lines are extended and do not meet, they are parallel. Parallel lines are lines that lie in the same plane and are equally distant from each other at all points (see Figure 15).

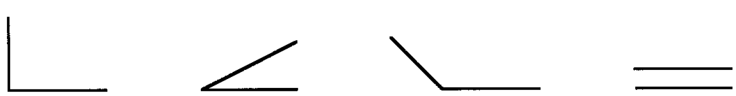


Figure 15
ANGLES AND PARALLELS

If two straight lines are extended and they do meet, they form an angle (see Figure 15).

ANGLES

An angle is the amount of opening between two straight lines that meet at one point. The lines are called sides and the point of meeting is called the vertex. The length of the sides makes no difference to the value of the angle.

Angles are usually named by placing a different letter (or in some cases a number) at the end of each side and at the vertex. In naming the angle, the letter at the vertex must always be read second, that is, it must be read between the other two letters (see Figure 16).

The unit of measure for an angle is a degree (°).

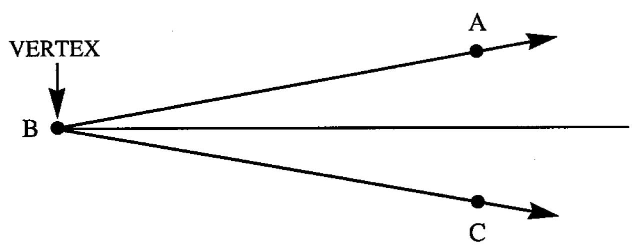


Figure 16
NAMING THE ANGLES

There are several different types of angles, many of which are used in the glazing trade. Some of the more common angles include (see Figure 17):

<u>Right Angle</u>
A right angle measures 90° and forms a square corner. A small square is used to indicate a right angle.

<u>Acute Angle</u>
An acute angle is any angle that measures less than 90°.

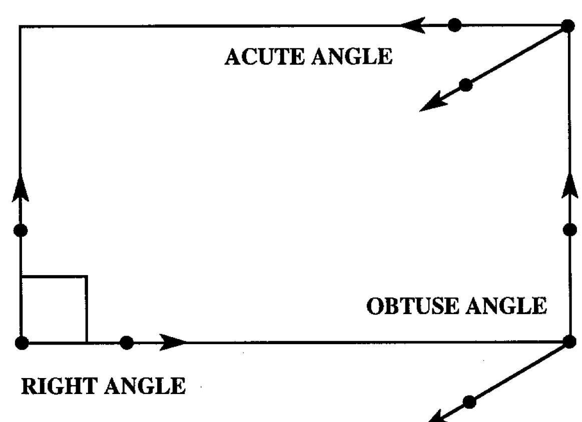


Figure 17
COMMON ANGLES

<u>Obtuse Angle</u>
An obtuse angle is any angle that measures greater than 90°.

POLYGONS

Adjacent Angles

When two lines intersect, they form four angles (see Figure 18). These four angles are called adjacent angles because they have the same vertex.

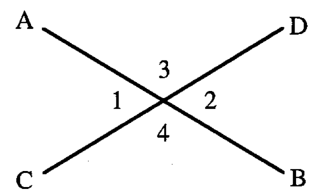


Figure 18
ADJACENT ANGLES

Complementary Angle

Two angles would be complementary if their sum was equal to 90°.

Supplementary Angle

Two angles would be supplementary when their sums equal 180°.

POLYGONS

A polygon is a simple closed figure formed by straight lines. The sum of the straight lines is called the perimeter.

The sides of the polygon meet to form angles. The point where the sides meet is called a vertex (see Figure 19).

Polygons are named according to the number of sides in the structure. Some of the smaller and more common polygons are:

Name	Number of Sides
Triangle	3
Quadrilateral	4
Pentagon	5
Hexagon	6
Heptagon	7
Octagon	8
Nonagon	9
Decagon	10

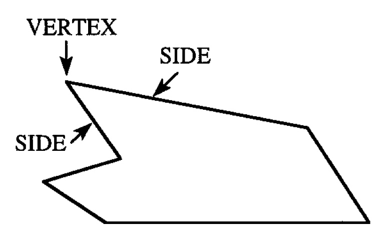


Figure 19— POLYGONS

Other polygons include (see Figure 20):

Parallelogram
A parallelogram is a quadrilateral whose opposite sides are parallel and equal.

Trapezoid
A trapezoid is a quadrilateral having only two parallel sides.

Trapezium
A trapezium is a quadrilateral having no two sides parallel.

Square
A square is a quadrilateral with all sides equal and with all angles being right angles.

Rectangle
A rectangle is a quadrilateral whose angles are right angles.

Rhombus
A rhombus is a quadrilateral all of whose sides are equal but whose angles are not right angles.

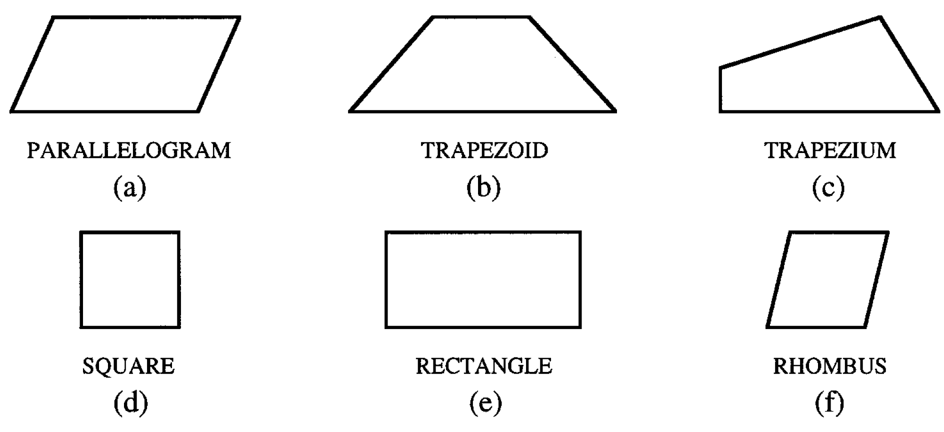


Figure 20—ADDITIONAL POLYGONS

TRIANGLES

A triangle is a polygon enclosed by three straight lines called sides. The sides of the triangle form various angles.

The altitude of a triangle can be found by drawing a perpendicular line from the triangle's vertex to the base. In some figures, like Figure 21, the base must be extended so that the altitude may meet it.

The base of a triangle is the side upon which the triangle is supposed to stand. Any side may be taken as the base. In an isosceles triangle, the side which is not one of the equal sides is usually considered the base.

If you were to cut off two points of any triangle and fit the three points (or angles) together (see Figure 21), the three angles will always be equivalent to two right angles or 180 degrees. If two angles of a triangle are known, the third is easily figured out since the three will equal 180 degrees.

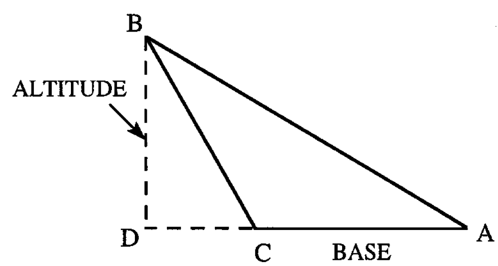


Figure 21—DETERMINING THE ALTITUDE OF AN OBTUSE TRIANGLE

Some of the more common triangles include:

<u>Obtuse Angle Triangle</u>
An obtuse angle triangle is one (see Figure 22), that has an angle greater than 90°.

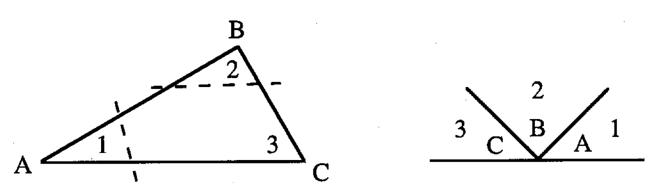


Figure 22—ESTABLISHING 180°

Right Angle Triangle

A right angle triangle, often called a right triangle (see Figure 23), is one that has a right angle. The longest side (the one opposite the right angle) is called the hypotenuse.

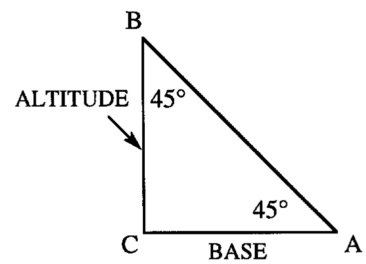


Figure 23—RIGHT ANGLE TRIANGLE

Acute Angle Triangle

An acute angle triangle (see Figure 24), is one where all the angles are acute (less than 90°).

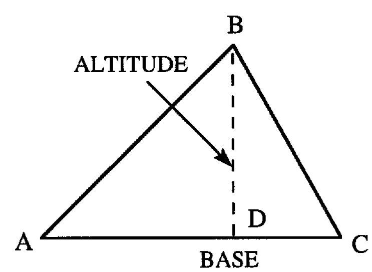


Figure 24—ACUTE ANGLE TRIANGLE

Equilateral Triangle

An equilateral triangle (see Figure 25), is one where all the sides are equal.

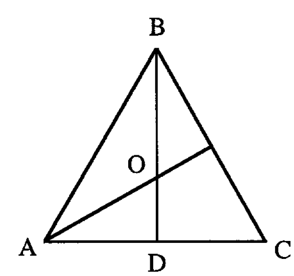


Figure 25—EQUILATERAL TRIANGLE

Isosceles Triangle

An isosceles triangle (see Figure 26), is a triangle that has two of its sides equal.

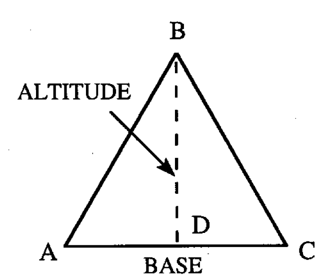


Figure 26—ISOSCELES TRIANGLE

Scalene Triangle

A scalene triangle (see Figure 27), is a triangle in which no two of its sides are equal.

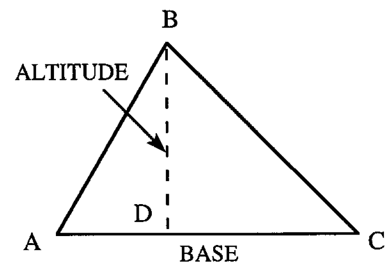


Figure 27—SCALENE TRIANGLE

PYTHAGOREAN THEOREM

If two sides of a right triangle are known, the third side can always be determined using the following Pythagorean Theorem:
A right triangle is a triangle that has one 90° angle.

The sides of a right triangle are related in a special way:
the sum of the squares of the lengths of the two shortest sides equals the square of the length of the longest side.

The two shorter sides are called legs and the longest side (always opposite the fight angle) is called the hypotenuse.

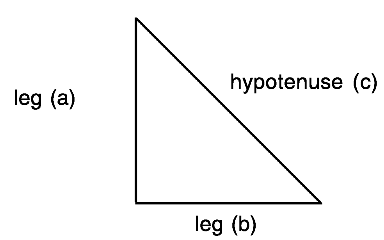
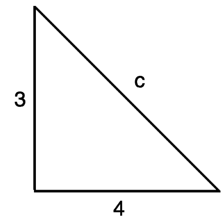


Figure 28—PYTHAGOREAN THEOREM

This fact, called the Pythagorean theorem, can also be stated as the sum of the squares of the legs equals the square of the hypotenuse.

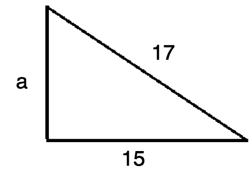
In short form, $a^2 + b^2 = c^2$

A. Find the length of the hypotenuse (c).



$a^2 + b^2 = c^2$	Use the formula.
$3^2 + 4^2 = c^2$	Substitute the known values.
$3 \times 3 + 4 \times 4 = c^2$	Simplify the powers.
$9 + 16 = c^2$	
$25 = c^2$	
$\sqrt{25} = \sqrt{c^2}$	Solve for c by finding the square root of both sides.
$5 = c$	

B. Find the length of the missing leg.



$a^2 + b^2 = c^2$	Use the formula.
$a^2 + 15^2 = 17^2$	Substitute the known values.
$a^2 + 15 \times 15 = 17 \times 17$	Simplify the powers.
$a^2 + 225 = 289$	
$-\underline{225} = -\underline{225}$	Subtract 225 from both sides.
$a^2 = 64$	
$\sqrt{a^2} = \sqrt{64}$	Solve for a by finding the square root of both sides.
$a = 8$	

MEASURING ANGLES

MEASURING ANGLES

The best tool for measuring angles is a protractor. A protractor measures angles in degrees and fractions of degrees.

Each degree is divided into 60 equal parts called minutes (‘). Each minute is divided into 60 equal parts called seconds (“).
These measurements may be summarized as follows:

60 seconds = 1 minute
60 minutes = 1 degree
360 degrees = 1 circle (or circumference)
90 degrees = 1 right angle
180 degrees = 2 right angles or a straight angle
360 degrees = 4 right angles or 1 circumference

USING A PROTRACTOR

A protractor is shaped like a half circle. To measure an angle with a protractor, place the center mark of the instrument on the vertex of the angle and the edge on one line of the angle (see Figure 29).

There will be two numbers to choose from where the second line crosses the scale. One of the set of numbers is used to measure an acute angle (one that is less than 90°) and the other measures obtuse angles (more than 90°). The sum of these two numbers will always equal 180°.

.
The line IK crosses the scale at 50° and 130°. Since the angle is obviously acute, we know that angle KIM is 50°.

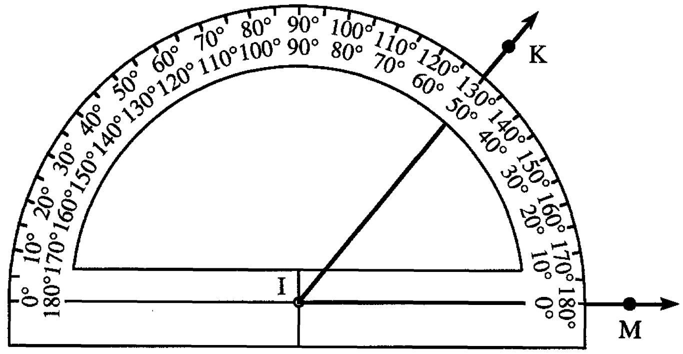


Figure 29—USING A PROTRACTOR TO DETERMINE AN ANGLE

PRACTICE PROBLEMS

The following numbers in each case represent two angles of a triangle. Find the size of the third angle.

51. 90 degrees and 45 degrees

52. 90 degrees and 60 degrees

53. 100' 30" and 30 degrees

54. 60 degrees and 60 degrees

55. What type of triangle would you call the one described in Practice Problem #54?

REVIEW

NAME: ________________________________ DATE: ____________

1. What is the purpose of a decimal point?

2. When adding or subtracting decimal fractions, why is it important that the decimals are lined up vertically?

3. When dividing decimal fractions, the divisor must be a whole number.

   TRUE / FALSE

4. The symbol for percent (%) means.

5. What is the definition for "parallel" lines?

6. What is formed when 2 straight lines meet?

7. What is the meeting point called in an angle where two lines or sides come together?

8. What is the definition of a right angle?

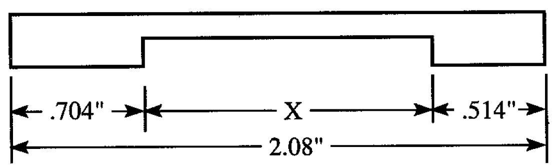
9. What is the definition of an acute angle?

10. What is the definition of an obtuse angle?

11. What tool is commonly used to measure angles?

12. What terms are angles measured in?

13. In the diagram below, find the missing dimension “X”.



Write each in decimal form:

14. 3/100 =

15. 1/1000 =

16. 17/100 =

17. 26/100 =

18. 6/10 =

Multiply the following:

19. 8.72 X 0.48 =

20. .87 X .69 =

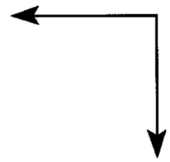
21. 1/4 X 3/5 =

22. 40% of 2.35 =

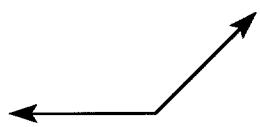
23. 7.82 X 3.63 =

Name the following angles:

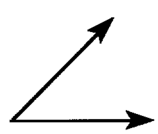
24.



25.



26.



Item #130