DOCUMENT RESUME

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ABSTRACT

One of a series of pre-apprenticeship phase 1 training modules dealing with math skills, this self-paced student module covers perimeters, areas, and volumes. Included in the module are the following: cover sheet listing module title, goals, and performance indicators; introduction; study guide/check list with directions for module completion; information sheet; self-assessment; self-assessment answers; and post assessment. Emphasis of the module is on problems involving measurement of perimeter, area, and volume that are frequently encountered by workers in the skilled trades. (Other related pre-apprenticeship phase 1 training modules are available separately--see note.) (MN)

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INDIVIDUALIZED LEARNING SYSTEMS

PRG-APPRENTICESHIP

PHASE 1 TRAINING

MATH

PERIMETERS, AREAS AND VOLUMES

CE032927

Goal:

The student will know the necessary math concepts in perimeters, areas and volumes to enable him or her to compute math problems in which these concepts are used.

Performance Indicators:

Given a series of math problems in the Self Assessment and Post Assessment portions of this module, the student will be able to successfully compute the answers.

Introduction

Problems involving the measurement of perimeters, areas, and volumes are frequently encountered on the job. A skilled worker in the construction trades, for example, may need to know not only the length and width of a room but also its perimeter and the areas of its floor, walls, and ceiling for estimating material and labor costs for interior finish work. He or she may also need to know the volume of air space of the room for heating and ventilating calculations. Measurements of perimeters, areas, and volumes are basic to every craft, and the apprentice must therefore become thoroughly familiar with the rules and procedures for making them.

Study Guide

This study guide is designed to help you successfully complete this module. Check off the following steps to completion as you finish them.

STEPS TO COMPLETION

1. ____ Familiarize yourself with the Goal and Performance Indicators on the title page of this module.

2. ____ Read the Introduction and study the Information section of the module. It is intended to provide you with the math skills necessary to successfully complete the assessment portions.

3. ____ Complete the Self Assessment section of the module. You may refer to the Information section for help.

4. ____ Compare your Self Assessment answers with the correct answers on the Self Assessment Answer Sheet immediately following the Self Assessment exam. If you missed more than one of the Self Assessment exam questions, go back and re-study the necessary portions of the Information section, or ask you instructor for help. If you missed one or none of these problems, go on to step 5.

5. ____ Complete the Post Assessment section of the module. Show your answers to the instructor. It is recommended that you score 90% or better on those Post Assessment exams with 10 or more problems, or miss no more than one problem on those with fewer than 10 problems, before being allowed to go on to the next math module.

Information

MEASURING PERIMETERS

The perimieter of an object--the distance around it--is found by adding the lengths of all its sides; the perimeter of a building lot 60' x 180' is therefore 60' + 180' + 60' + 180', or 480'. The perimieter of the irregularly shaped structure in the plan view, Fig. D-1, will be found to be 68' if the dimensions of all its sides are added.

MEASURING AREAS

Measurements of areas are expressed in units of square measure--square inches, square feet, square yards, and the like. The area of a square or other rectangle is found by multiplying its length by its width. The result will always be in units of square measure. For example, the area of a plywood panel 4' wide by 8' long is 32 square feet.

Since a linear foot is equal to 12", a square foot (1 foot each way) contains 12" x 12", or 144 square inches. (See Fig. D-2.) Expressions of square measure must be read carefully if mistakes are to be avoided: note that 10-inch square (one square measuring 10" x 10") is not the same as 10 square inches (ten squares, each measuring 1" x 1").

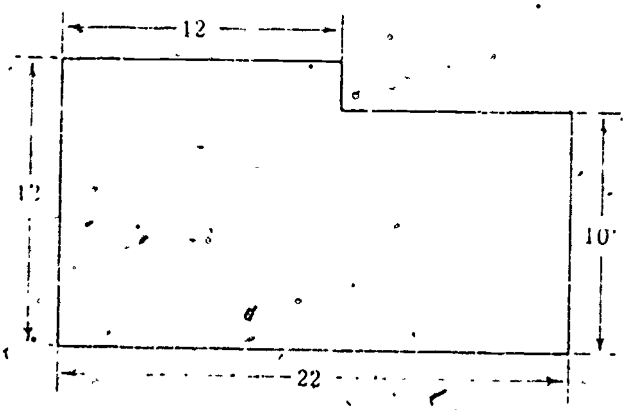


Fig. D-1 Perimeter measurement

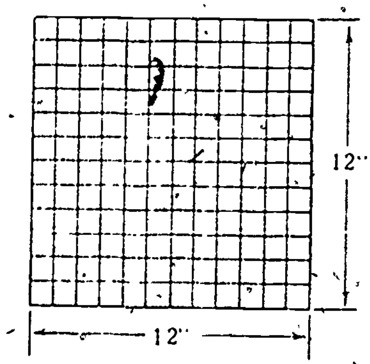


Fig. D-2 A 12-inch square (one square foot) contains 144 square inches

AREA OF A RECTANGLE

Multiplying two adjacent sides gives the area of a square or other rectangle. In a square, all four sides are of equal length and all four corners are right angles; other rectangles differ from the square in that their sides and ends are of unequal length. (See Figs. D-3A and D-3B.) A rectangle that is not a square is commonly called an oblong. Since all sides of a square are of equal length, the area of a square is found by multiplying any side by itself; the area of an oblong is found by multiplying its length by its height.

Any four-sided plane figure whose opposite sides are straight and parallel is a parallelogram. Squares and oblongs meet this definition, but the word parallelogram usually applies specifically to a four-sided plane figure whose oppostie sides are parallel but whose corners are not right angles. A parallelogram can be thought of as a rectangle with a triangle removed from one end and tacked onto the other end. (See Fig. D-3C.) To compute the area of a parallelogram, multiply base X height (altitude). The base of the parallelogram in Fig. D-3C is 14", and its altitude is 10"; therefore its area is 10" x 14", or 140 square inches.

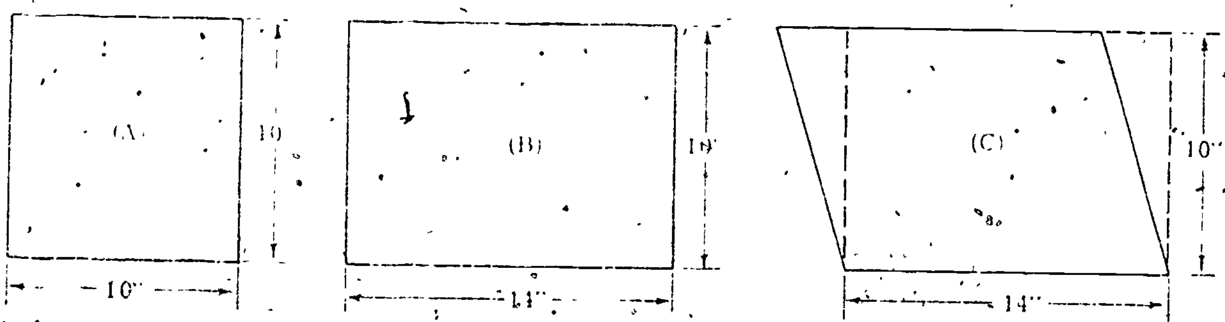


Fig. D-3. Four-sided plane figures: (A) square; (B) oblong; (C) parallelogram

AREA OF A TRIANGLE

A triangle is a plane figure with three sides, each side being a straight line. A square-cornered or right triangle has one right angle (Fig. D-4A). In an acute triangle, each of the three angles is less than a right angle (Fig. D-4B). An obtuse triangle has one angle that is greater than a right angle (Fig. D-4C).

Any triangle is really one-half of a rectangle (or one-half of a parallelogram, in the case of an acute or an obtuse triangle). This can be seen clearly in Fig. D-4A, where an identical but inverted right triangle is drawn above the shaded right triangle, making a rectangle. Similarly, "mirror-image" triangles could be joined to the acute and obtuse angles in Figs. D-4B and D-4C to make parallelograms.

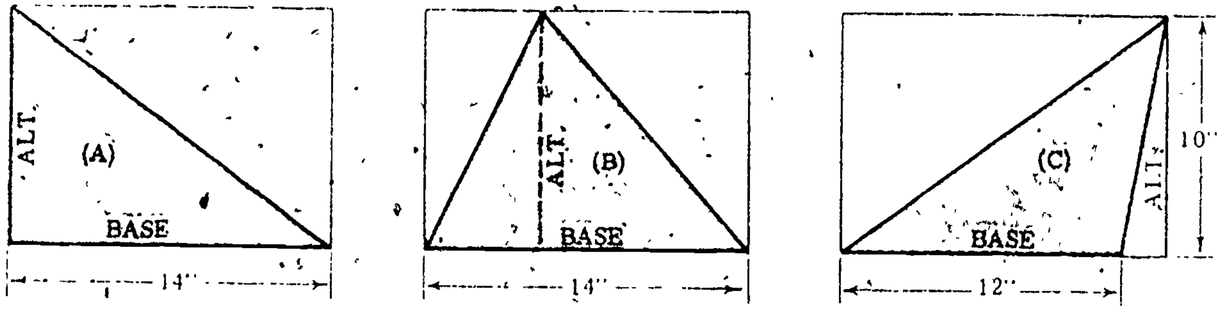
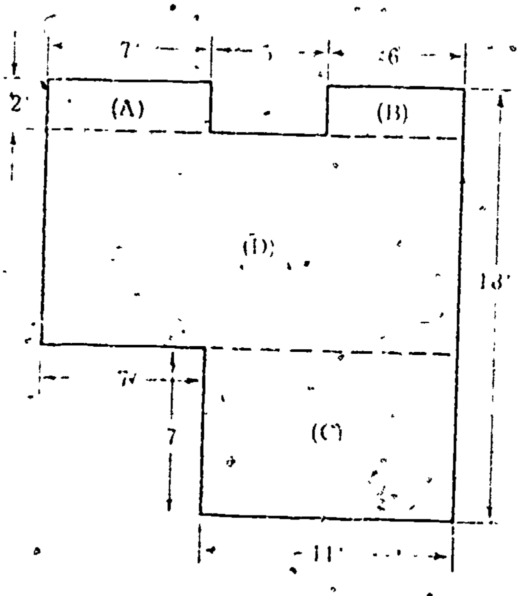


Fig. D-4. Triangles: (A) right; (B) acute; (C) obtuse

The area of a rectangle or a parallelogram is euqal. to its length (base) times its height (altitude). Since a rectangle or a parallelogram can be made by joining two identical triangles, it follows that the area of any triangle is equal to one-half the product of its base and its altitude. The area of the right triangle in Fig. D-4A is therefore 70 square inches; the area of the acute triangle in Fig. D-4B is 70 square inches; and the area of the obtuse angle in Fig. D-4C is 60 square inches.

AREAS OF IRREGULAR SHAPES

Any skilled worker may occasionally find it necessary to determine the area of an irregularly shaped surface. For a practical problem of this kind, assume that a worker needs to determine the area of the floor in a room having a number of projections and recesses. He or she can compute the total floor area in either of two ways: he or she can divide the irregular floor shape into smaller rectangular shapes, then compute the areas of these rectangles and take their sum; or square out the irregular floor shape, compute the area of the resulting square, then subtract from that the areas of the cutouts. (See Fig. D-5.)

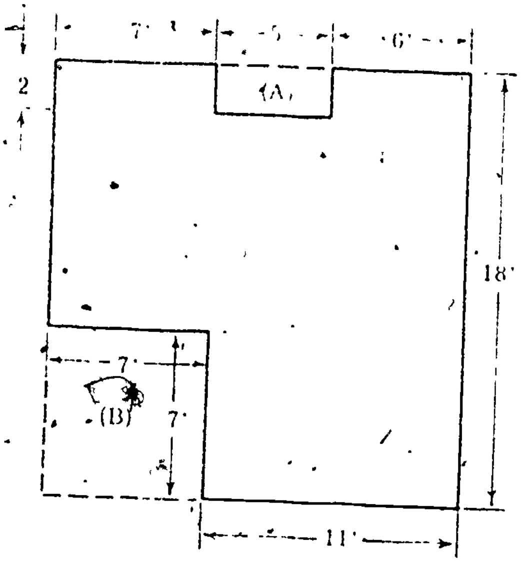


Method 1. Divide the floor area into rectangular units (A, B, C, and D); then compute the area of each unit and add the unit areas.

A)	7' x 2' =	14	sq. ft.
B)	6' x 2' =	12	sq. ft.
C)	7' x 11' =	77	sq. ft.
D)	9' x 18' =	162	sq. ft.
		265	sq. ft.

Fig. D-5, 1

Method 1: A + B + C + D = 265 sq. ft.



Method 2. Enclose the floor area in a square; find the area of the square, then subtract the areas of the cutouts (units (A and B).

18' x 18' = 324 sq. ft.

A) 2' x 5' = 10 sq. ft.
B) 7' x 7' = <u>49</u> sq. ft.
59 sq. ft.

324 sq. ft.
<u>-59</u> sq. ft.
265 sq. ft.

Method 2. A + B subtracted from total area - 265 sq. ft.

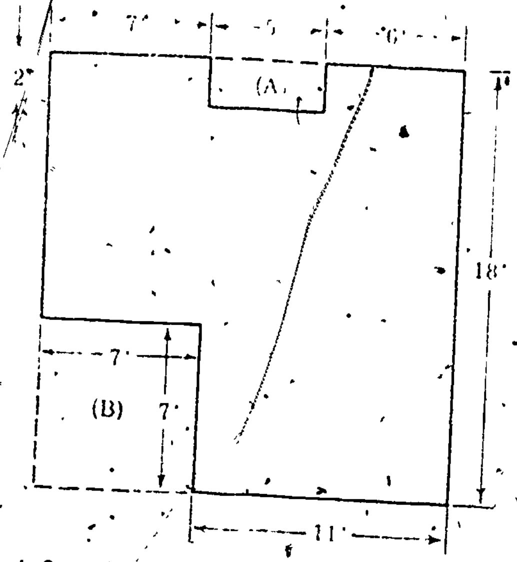
Fig. D-5, 2. Finding the area of an irregularly shaped floor

MEASURING VOLUMES

The plane figures described thus far in this topic have the dimensions of length and width only. Because solid objects have thickness as well as length and width, they occupy or enclose space. The amount of space taken by a solid object is its volume. Volume is commonly expressed in cubic measure--cubic yards, cubic feet, or cubic inches, for example--but it can also be expressed in liquid measure (gallons, quarts, pints or ounces) or dry measure (bushels or pecks). Volumes expressed in one kind of measure can be changed to volumes expressed in another measure by means of conversion constants. For example, a cubic foot is equal to 7.48 U.S. gallons, and a bushel is equal to 1.244 cubic feet.

To find the cubic measure of a body such as a cube or a box, where all the corner angles are right angles, multiply length times width times thickness. The result is expressed in cubic units. The dimensions of the box in Fig. D-6 are 2" x 2" x 1". The box therefore encloses (has a volume of) 4 cubic inches. As in the case of square measure, care must be taken in expressing cubic measure if mistakes are to be avoided; a 10-inch cube is not equivalent in volume to 10 inches.

If the shape of an object is such that its ends (or its top and bottom) are identical, parallel, and exactly opposite each other, and if the straight lines bounding the sides of the object are all parallel (as in the shapes shown in Fig. D-7), the volume of the object can be found by multiplying the area of one end (or of the top or bottom) by the length (or height) of the object. If for example the



Method 2. Enclose the floor area in a square; find the area of the square, then subtract the areas of the cutouts (units (A and B).

18' x 18' = 324 sq. ft.

A) 2' x 5' = 10 sq. ft.
B) 7' x 7' = 49 sq. ft.
59 sq. ft.

324 sq. ft.
-59 sq. ft.
265 sq. ft.

Method 2. A + B subtracted from total area - 265 sq. ft.

Fig. D-5, 2. Finding the area of an irregularly shaped floor

MEASURING VOLUMES

The plane figures described thus far in this topic have the dimensions of length and width only. Because solid objects have thickness as well as length and width, they occupy or enclose space. The amount of space taken by a solid object is its volume. Volume is commonly expressed in cubic measure--cubic yards, cubic feet, or cubic inches, for example--but it can also be expressed in liquid measure (gallons, quarts, pints or ounces) or dry measure (bushels or pecks). Volumes expressed in one kind of measure can be changed to volumes expressed in another measure by means of conversion constants. For example, a cubic foot is equal to 7.48 U.S. gallons, and a bushel is equal to 1.244 cubic feet.

To find the cubic measure of a body such as a cube or a box, where all the corner angles are right angles, multiply length times width times thickness. The result is expressed in cubic units. The dimensions of the box in Fig. D-6 are 2" x 2" x 1". The box therefore encloses (has a volume of) 4 cubic inches. As in the case of square measure, care must be taken in expressing cubic measure if mistakes are to be avoided; a 10-inch cube is not equivalent in volume to 10 inches.

If the shape of an object is such that its ends (or its top and bottom) are identical, parallel, and exactly opposite each other, and if the straight lines bounding the sides of the object are all parallel (as in the shapes shown in Fig. D-7), the volume of the object can be found by multiplying the area of one end (or of the top or bottom) by the length (or height) of the object. If for example the

the area of one end of the prism shown at the left in Fig. D-7 is 10 square inches and the length of prism is 15 inches, the volume of the prism will be 10 square inches x 15 inches, or 150 cubic inches.

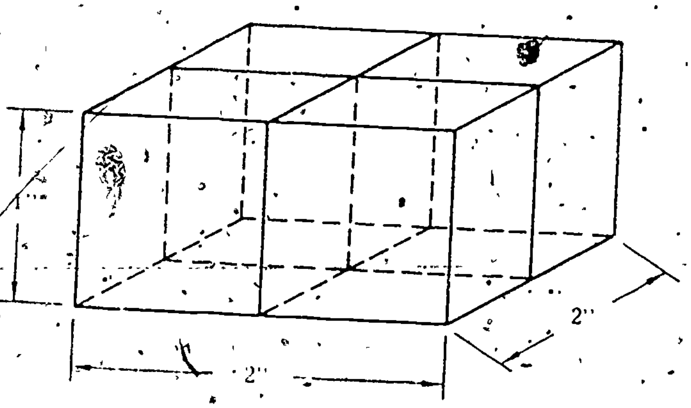


Fig. D-6
Cubic measure

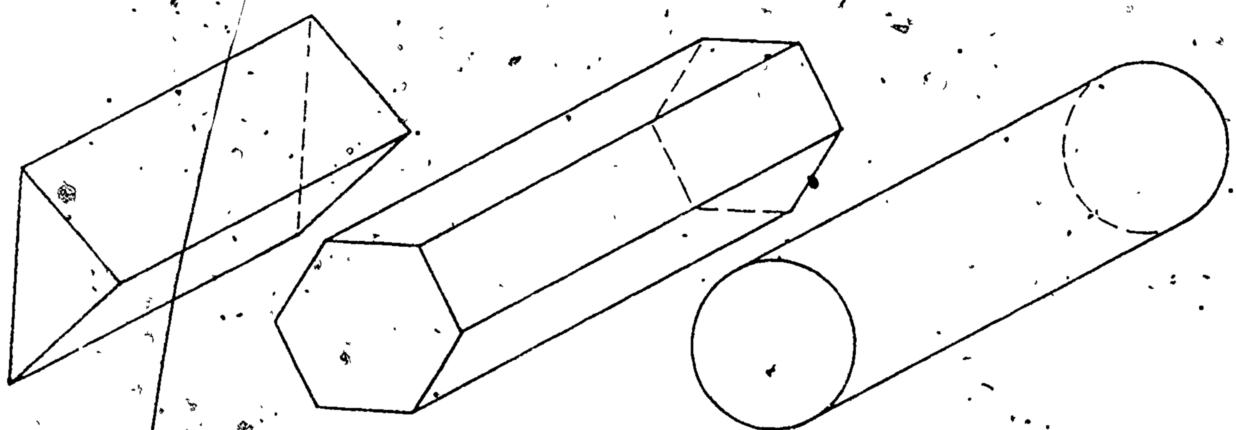


Fig. D-7. Solids with identical ends and straight sides

The volume of an irregularly shaped object can best be found by thinking of the object as being made up of a number of smaller solid shapes. (See Fig. D-8.) The separate volumes of these smaller shapes can then be computed and added to find the total volume.

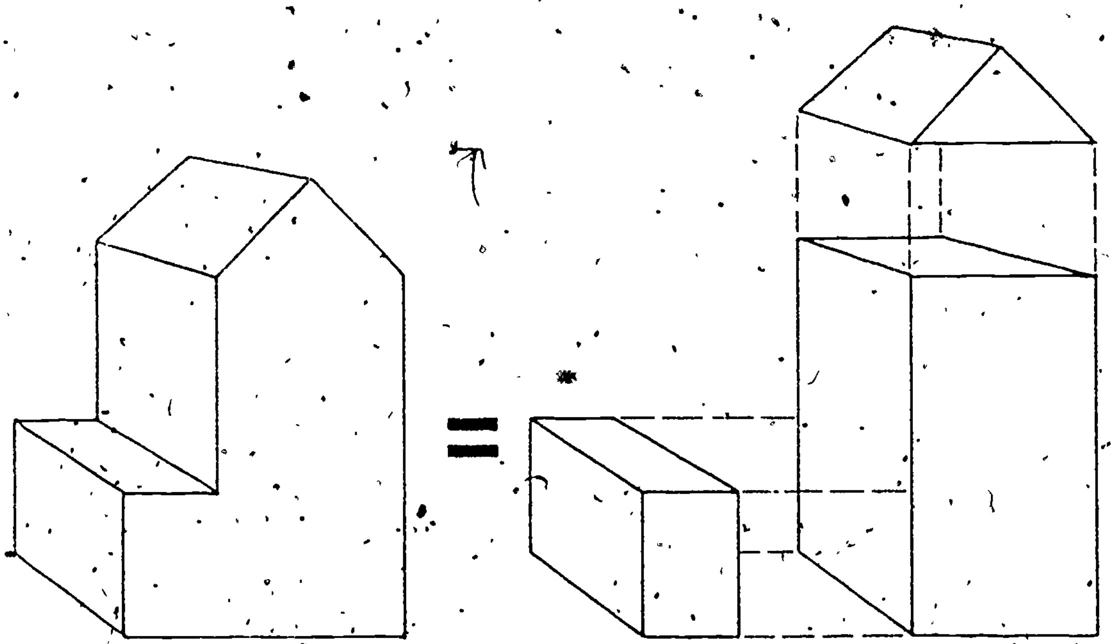


Fig. D-8. Finding the volume of an irregularly shaped object.

Self Assessment

Write the answer to each problem in the corresponding space at the left.

1. ________ What is the perimeter of a room 20' wide and 30' long?

2. ________ What is the perimeter of a room 16' square?

3. ________ What is the area, in square feet, of a floor 42' by 42'?

4. ________ What is the area, in square inches, of a 9" square floor tile?

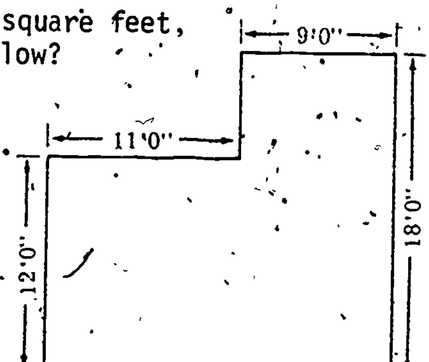
5. ________ What is the floor area, in square feet, of a room 15' long and 12' wide?

6. ________ What is the area, in square yards, of a rectangle 20' long and 9' wide?

7. ________ What is the area, in square inches, of a right triangle with a base of 8 1/2" and an altitude of 11 1/4"?

8. ________ What is the area, in square inches, of an acute triangle with a base of 8 1/2" and an altitude of 11 1/4"?

9. ________ What is the area, in square feet, of the floor shown below?



Self Assessment Answers

1. 100 ft.

2. 64 ft.

3. 1,764 sq. ft.

4. 81 sq. inches

5. 180 sq. ft.

6. 6 2/3 sq. yards

7. 47.8 sq. inches

8. 47.8 sq. inches

9. 294 sq. ft.

Post Assessment

Listed below each problem are four possible answers. Decide which of the four is correct, or most nearly correct; then write the letter for that answer in the blank space to the left of the problem.

1. ____ What is the perimeter of a rectangle 8' wide and 12' long?
   a. 32'
   b. 34 1/2'
   c. 37 1/2'
   d. 40'

2. ____ What is the perimeter of a rectangle 17 1/2' wide and 12 1/2' long?
   a. 40'
   b. 60'
   c. 80'
   d. 100'

3. ____ What is the perimeter of a rectangle 67'7" wide and 96'4" long?
   a. 237'10"
   b. 297'10"
   c. 327'10"
   d. 377'10"

4. ____ What is the area in square feet of a rectangle 32'9" wide and 52'6" long?
   a. 1,709.0
   b. 1,719.375
   c. 1,729.875
   d. 1,740.0

5. ____ An excavation for a basement is to be 40' long, 27' wide, and 8' deep. After 210 cu. yd. of dirt have been removed, how many cubic yards remain to be excavated?
   a. 90
   b. 110
   c. 115
   d. 120

6. ____ How many cubic feet of concrete are in a slab 12' long, 4' wide, and 1' thick?
   a. 40
   b. 42 1/2
   c. 44 1/2
   d. 48

7. ____ What is the volume in cubic inches of a 25" cube?
   a. .625
   b. 975
   c. 12,380
   d. 15,625

8. ____ What is the area in square feet of a room 14' square?

a. 56
b. 112
c. 196
d. 208

9. ____ How many cubic yards of concrete will be needed for a garage floor 20' x 32' x 4", allowing 3 cu. yd. extra for foundation walls and footings?

a. 4.9
b. 6.9
c. 7.9
d. 10.9

10. ____ How many cubic yards of concrete will be needed for the foundation walls and footings in the plan below if the walls are 6" thick and 18" deep, and if the footings (shown in dotted lines) will require 2 5/27 cu. yd. of concrete?

a. 6
b. 6 2/3
c. 7
d. 7 1/6