GENERAL MATHEMATIC FACTS

PLEASE EXCUSE MY DEAR AUNT SALLY

PARENTHESIS WHEN NUMBERS ARE SET IN PARENTHESIS LIKE THESE, ( )
YOU SOLVE WHAT IS WITHIN THE PARENTHESIS FIRST

EXAMPLE: 3 + (5 - 1) = ? **FIRST (5 - 1) = 4** **THEN, 3 + 4 = 7**

EXPONENTS AND SQUARE ROOTS OF A NUMBER.

EXAMPLE: 8^2 IS 8 TO THE SECOND POWER, OR 8 x 8 THIS IS 64
8^3 IS 8 TO THE THIRD POWER, OR 8 x 8 x 8 THIS IS 512

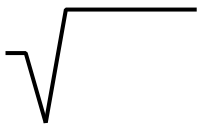
TO SQUARE ANY NUMBER, SIMPLY MULTIPLY THE NUMBER BY ITSELF

EXAMPLE: √8 WHAT IS THE SQUARE ROOT OF 8 ?

THE SQUARE ROOT OF 8 IS EXPRESSED AS: √8 = 2.828
THE SQUARE ROOT OF 9 IS EXPRESSED AS: √9 = 3

TO UN-SQUARE A NUMBER ON THE CALCULATOR PRESS THE SQUARE ROOT KEY

MULTIPLICATION: MUST PRECEDE ANY ADDITION OR SUBTRACTION



MULTIPLY 12 TIMES 3 PLUS 2 **ANSWER: (12 x 3) = 36 + 2 = 38**

NOTE: WHEN ANY NUMBER IS SET NEXT TO A LETTER OR PARENTHESIS, READ THE EQUATION AS "MULTIPLY BY" , UNLESS THERE IS ANOTHER SPECIFIC MATHEMATICAL OPERATOR SHOWN. **EXAMPLE: 2 (5 - 2) = ?**

THIS IS READ AS 2 TIMES THE ANSWER OF (5 - 2) OR 2 x 3 = 6

2 R IS READ 2 x R WHEN R = RADIUS IT IS READ AS 2 x THE RADIUS

2 π IS READ 2 x π SINCE π = 3.14 IT IS READ AS 2 x 3.14

π R^2 IS READ AS 3.14 x (RADIUS x RADIUS) **π = 3.14**

DIVISION: DIVIDE 12 BY 3 $12 / 3 = 4$ OR $\frac{12}{3} = 4$

OR BY HAND:

$$3 \overline{)\,12} = 4$$
$$-12$$
$$0$$

ADDITION: WHEN ADDING NUMBERS, ANY NUMBER SET IN BRACKETS < > IS TO BE SUBTRACTED FROM OTHERS IN THE PROBLEM.

EXAMPLE:	100.00	
	50.00	
	< 25.00 >	**SUBTRACT**
	30.00	
ANSWER:	155.00	

SUBTRACTION: IS TO BE THE LAST OF ALL MATHEMATICAL OPERATORS.

EXAMPLE: CALCULATE 7 x 7 - 2 **ANSWER:** 7 x 7 = 49 - 2 = 47

LET'S REVIEW THE ORDER IN WHICH WE SOLVE MATHEMATICAL PROBLEMS AGAIN.

P	PARENTHESIS	WILL BE SOLVED FIRST
E	EXPONENTS	ARE NEXT, FOLLOWED BY
M	MULTIPLICATION	THEN,
D	DIVISION	THEN,
A	ADDITION	AND
S	SUBTRACTION	IS LAST.

PLEASE EXCUSE MY DEAR AUNT SALLY

GENERAL PROBLEM SOLVING

ALWAYS READ AN ENTIRE PROBLEM, AND THINK OF IT LIKE THIS:
EACH PROBLEM IS LIKE A MAP. IF YOU HAVE A MAP OF FLORIDA, IT IS OF NO USE TO YOU UNLESS YOU KNOW WHERE YOUR GOING. THIS IS YOUR DESTINATION. THE QUESTION WILL TELL YOU YOUR " DESTINATION ". IT IS ONE SENTENCE IN THE PROBLEM. YOUR ANSWERS WILL TELL YOU WHAT DEGREE OF ACCURACY YOU NEED TO ARRIVE AT WHEN YOU HAVE REACHED YOUR " DESTINATION ". ONCE THESE ITEMS ARE CONSIDERED, YOU CAN ESTABLISH A " ROUTE ". THIS WILL BE A **GRID, FORMULA, OR METHOD OF THOUGHT** THAT YOU ASSIGN IN ADVANCE. IF YOU CAN NOT THINK A PROBLEM THROUGH AND ESTABLISH A ROUTE, SKIP THE PROBLEM AND PROCEED TO THE NEXT.

" SUMMARIZE YOUR THOUGHTS "

* READ THE ENTIRE PROBLEM, TWICE	(THE MAP)
* FIND YOUR DESTINATION	(WHAT IS ASKED)
* LOOK TO THE ANSWERS TO DETERMINE ACCURACY	(ANSWER RANGE)
* ESTABLISH THE ROUTE	(GRID OR FORMULA)

UNDERSTANDING SOLUTION SUB AND SUPERSCRIPT NOTES

A SUPERSCRIPT IN **FRONT** OF A NUMBER MEANS THERE IS A FOOTNOTE UNDER THE SOLUTION THAT WILL EXPLAIN HOW THAT NUMBER WAS OBTAINED: . . . . . $^{1}120$
The superscript ^{1} *means there is a footnote that will explain where the* 120 *was obtained*

A SUPERSCRIPT IN **BACK** OF A NUMBER IS AN EXPONENT: . . . . . 120^{2}
The superscript ^{2} *means that the number is to be "squared" or taken to the second power*

A SUBSCRIPT BEHIND A NUMBER MEANS THAT IT IS SOME PART OF A SERIES OF THE ITEMS: R_1, R_2, R_3 etc.. *The subscript* 1,2,3, *means that* R_1 *is one in a series,* R_2*, is another in a series, etc...*

1. **DECIMAL EQUIVALENT OF A FOOT AND RULER MEASUREMENT**

TO CONVERT INCHES TO THEIR DECIMAL EQUIVALENT OF A FOOT,
SIMPLY DIVIDE EACH BY 12

INCH	2"	3"	4"	6"	8"	9"	10"
DECIMAL EQUIVALENT OF A FOOT	.17'	.25'	.33'	.5'	.67'	.75'	.83'

1.1 IF YOU HAVE THESE MEMORIZED, SEE HOW THIS CAN HELP YOU.

WHAT IS THE RULER MEASUREMENT FOR THE CALCULATED ANSWER OF 8.7083'

SINCE THE 8 REPRESENTS 8 FOOT, THEN, .7083' IS MORE THAN 8" (.67')
.7083' IS LESS THAN 9" (.75')
ANSWER: 8'- 8 1/2"

1.2 CONVERT 7 5/8" TO IT'S DECIMAL EQUIVALENT OF A FOOT.

STEP 1. TO CONVERT THE FRACTION 5/8" DIVIDE 5 BY 8, THIS IS .625"
STEP 2. ADD 7" TO .625" = 7.625"
STEP 3. CONVERT IT TO DECIMAL EQUIVALENT BY DIVIDING BY 12
ANSWER: 7.625" / 12 = .635'

1.3 UNDERSTANDING FRACTIONS:

$$\frac{5}{16}$$

5 IS THE NUMERATOR
16 IS THE DENOMINATOR

1.4 CONVERT .635' TO RULER MEASUREMENT.

STEP 1. .635' X 12 = 7.625" (FULL INCHES AND PARTS OF AN INCH)
STEP 2. .625" X 16 = 10 (NUMBER OF 16^{TH}) ROUND TO NEAREST
STEP 3. REDUCE

$$\frac{10}{16} = \frac{5}{8}$$

(10/16 CAN BE REDUCED TO 5/8)

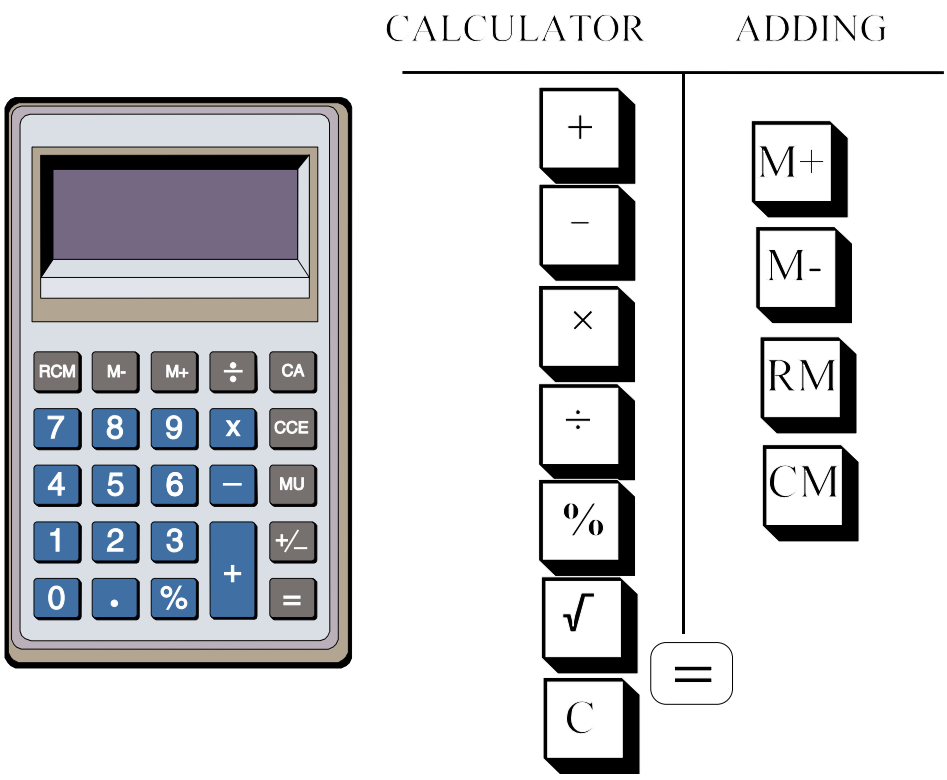
TO REDUCE TO THE LOWEST COMMON DENOMINATOR,
DIVIDE THE NUMERATOR AND DENOMINATOR BY 2.

ANSWER = 7 5/8"

2 USING YOUR CALCULATOR

YOUR CALCULATOR IS TWO SEPARATE MACHINES IN ONE CASE. ONE SIDE IS A CALCULATOR, THE OTHER SIDE IS AN ADDING MACHINE. THIS WILL ALLOW YOU TO CALCULATE NUMBERS ON ONE SIDE WHILE KEEPING A RUNNING TOTAL ON THE OTHER.

THE IMPORTANT THING TO REMEMBER IS THAT FOR A NUMBER ON THE CALCULATOR SIDE TO GO TO THE MEMORY SIDE, YOU MUST GO THROUGH THE "EQUALS" KEY. SO, IF YOU HAVE TOUCHED ANY OF THE CALCULATOR KEYS, YOU MUST FINISH THE EQUATION BY FIRST ROUTING THROUGH EQUALS BEFORE YOU TOUCH ANY OF THE MEMORY KEYS.



2.1 FOR EXAMPLE, PRESS 12 X 3 ON THE CALCULATOR.

NOTE THAT THE ONLY THING ON YOUR SCREEN IS THE NUMBER 3. IF YOU WERE TO PRESS **M+** AT THIS POINT, YOU WOULD GET THE ANSWER OF 36 **IN MEMORY** SINCE THE EQUATION IS FINISHED BY ROUTING THROUGH “EQUALS” PRIOR TO BE PLACED IN THE MEMORY SIDE.

2.2 CLEAR YOUR CALCULATOR AND MEMORY. PRACTICE WITH YOUR MEMORY KEYS BY PERFORMING THE FOLLOWING EQUATION.

$$(2 \times 3) + (6 / 2) - (3 + 1) + 5 = ?$$

2 X 3	M+		
6 / 2	M+		
3 + 1	M-		
5	M+,	THEN MR	**ANSWER = 10**

2.3 TO SQUARE THE NUMBER 10, YOU WOULD PRESS

10 X 10 = 100 OR IS YOUR CALCULATOR SELF SQUARING 10 X = 10 X = 100 M+

NOW, GO ONE STEP FURTHER: ADD $10^2 + 20^2$

10 X	M+		
20 X	M+,	THEN, MR	**ANSWER = 500**

3. CONSTANTS

LET'S REVIEW THE CONSTANTS USED IN CONSTRUCTION CALCULATIONS. CONSTANTS CAN BE FOUND IN THE VARIOUS REFERENCE BOOKS.

NOTE: IT IS BEST TO MEMORIZE AS MANY OF THESE AS POSSIBLE !
FIND WHICH CONSTANTS RELATE TO YOUR TRADE.

SQUARE

144 SQUARE INCHES = 1 SQ. FOOT
9 SQUARE FEET = 1 SQ. YARD
100 SQUARE FEET = 1 SQUARE
43,560 SQUARE FEET = 1 ACRE

WATER

1 GALLON WEIGHS = 8.34 LBS.
1 CUBIC FOOT WEIGHS = 62.5 LBS.
231 CUBIC INCHES = 1 GALLON
7.48 GALLONS = 1 CUBIC FOOT

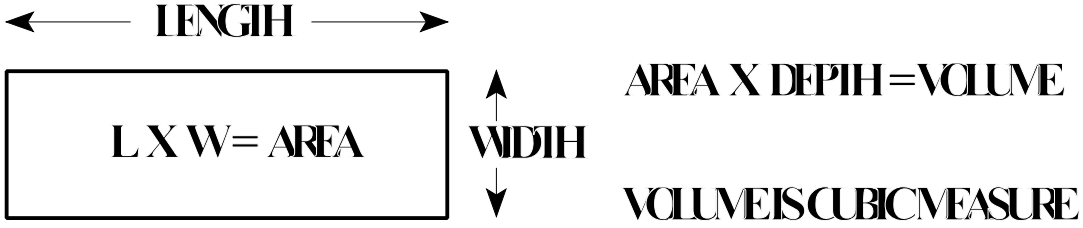
CUBIC

1,728 CUBIC INCHES = 1 CUBIC FOOT
27 CUBIC FEET = 1 CUBIC YARD
1 CUBIC FOOT = 7.48 GALLONS

MISCELLANEOUS

1 CUBIC FOOT OF STEEL = 490 LBS.
2,000 LBS. = 1 TON
1 MILE = 5,280 FEET IN LENGTH
1 INCH = 2.54 CENTIMETERS
1 METER = 3.28 FEET
1 MIL = 1/1,000 OF AN INCH

4. **SQUARE OR RECTANGLE**



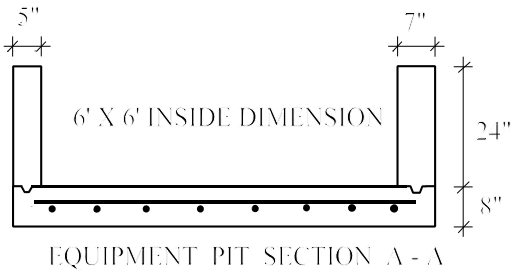
4.1 AN AREA THAT MEASURES 26'- 6" IN LENGTH BY 8'- 4" IN WIDTH WOULD CONTAIN ___?___ SQUARE FEET.

SOLUTION:	L'	X	W'	=	SQUARE FEET
	26.5'	**X**	**8.33'**	**=**	**220.75**

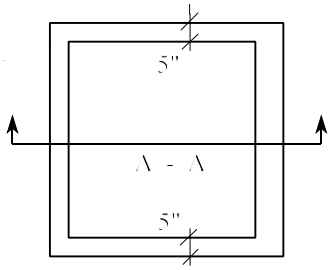
4.2 A ROOM THAT MEASURES 12'- 8" IN LENGTH, 10'- 8" IN WIDTH AND 8'- 0" IN HEIGHT WOULD CONTAIN ___?___ CUBIC FEET OF VOLUME.

SOLUTION:	L'	X	W'	X	D'	=	CUBIC FEET
	12.67'	**X**	**10.67'**	**X**	**8'**	**=**	**1081.5**

4.3 IT WOULD REQUIRE ____?____ CUBIC YARDS OF CONCRETE TO POUR THE EQUIPMENT PIT SHOWN BELOW, BASED ON THE GIVEN DIMENSIONS.



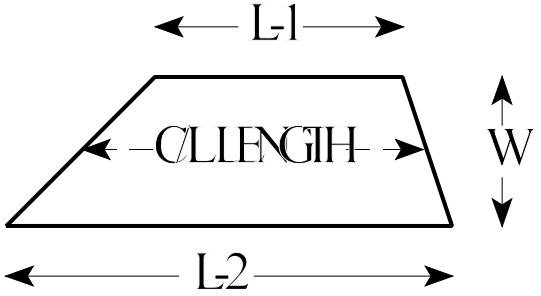
EQUIPMENT PIT SECTION A - A



EQUIPMENT PIT

SOLUTION: ESTIMATE SOLID VOLUME, THEN SUBTRACT THE VOID
OUTSIDE L' X W' X D' / 27 MINUS THE INSIDE L' X W' X D' / 27 = NET

7'	**X**	**6.83'**	**X**	**2.67'**	**/ 27**	**= 4.72**	**CUBIC YARDS (SOLID)**
6'	**X**	**6'**	**X**	**2'**	**/ 27**	**= < 2.66 >**	**CUBIC YARDS (VOID)**
						2.06	**NET CUBIC YARDS**



$$\frac{L\text{-}1 + L\text{-}2}{2} = C/L\ LENGTH$$

C/L LENGTH X W = AREA

AREA X DEPTH = VOLUME

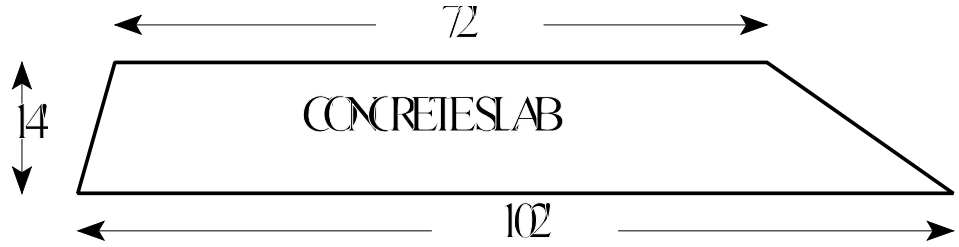
5. **TRAPEZOIDS**

5.1 AN AREA SHAPED LIKE A TRAPEZOID HAS A DIMENSION (L-2) OF 175' AND A DIMENSION (L-1) OF 125'. THE AREA IS 55'- 3" IN WIDTH. THE AREA HAS ____?____ SQUARE FEET.

SOLUTION: (L-1 + L-2) / 2 = C/L L' X W' = SF AREA
(175' + 125') / 2 = 150' X 55.25' = 8,287.5

5.2 ____?____ CUBIC YARDS OF MATERIAL WOULD BE REQUIRED, IF THE AREA ABOVE MEASURED 9" IN DEPTH THROUGHOUT.

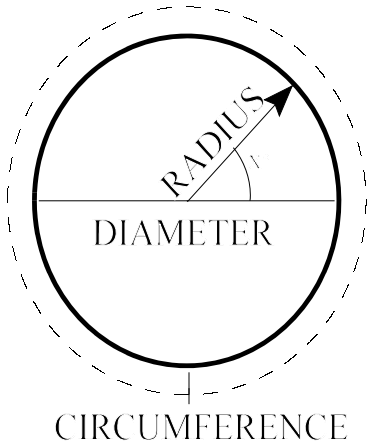
SOLUTION: AREA SF X DEPTH / 27 = CUBIC YARDS
8,287.5 X .75' / 27 = 230.2



5.3 THE SLAB SHOWN BELOW WOULD REQUIRE ____?____ CUBIC FEET OF CONCRETE, IF THE CONCRETE IS TO BE 4" THICK.

SOLUTION: (L-1' + L-2') / 2 = C/L L' X W' = SF X D' = CUBIC FEET
(72' + 102') / 2 = 87' X 14' = 1,218 X .33' = 402 CF

6. **CIRCLES**



AREA = πR^2 *which is 3.14 x radius x radius*

AREA X DEPTH = VOLUME

CIRCUMFERENCE = πD

which is 3.14 x diameter, or, 3.14 x radius x 2

REMEMBER: THE RADIUS IS 1/2 OF THE DIAMETER

DIAMETER = $\sqrt{((AREA \times 4) \div \pi)}$

VARIABLE CICUMFERENCE

$$3.14 \times D \times \frac{X^\circ}{360} = LENGTH$$

AREA

$$3.14 \times R \times R \times \frac{X^\circ}{360} = AREA$$

6.1 A CIRCULAR AREA IS FORMED. THE OUTSIDE DIAMETER OF IS 20' FEET. THE SURFACE AREA IS TO HAVE A 6 MIL WATERPROOF COATING APPLIED. THE DEPTH IS TO BE 4". THE CIRCUMFERENCE OF THE AREA WOULD BE ____?____ FEET.

SOLUTION: CIRCUMFERENCE = πD OR 3.14 X DIAMETER
3.14 X 20 = 62.8'

6.2 THE SURFACE AREA WILL REQUIRE __?__ GALLONS OF COATING.

SOLUTION: FIND SURFACE AREA AREA = πR^2

3.14	X	RADIUS	X	RADIUS	=	SF
3.14	**X**	**10'**	**X**	**10'**	**=**	**314**

AREA	X	[1] 144	X	[2] MILS	/	[3] 231	=	GALLONS
314	**X**	**144**	**X**	**.006**	**/**	**231**	**=**	**1.17 GAL.**

[1] TO CONVERT SQUARE FEET TO SQUARE INCHES, MULTIPLY BY 144
[2] 6 MIL IS 6 / 1,000 OR .006 ON THE CALCULATOR
[3] 231 CUBIC INCHES = 1 GALLON

6.3 THE CUBIC YARD VOLUME OF THE CYLINDRICAL SHAPE WOULD BE __?__

SOLUTION: AREA = πR^2 AREA X DEPTH = VOLUME

3.14	X	RADIUS	X	RADIUS	X	D'	/ 27	=	CY
3.14	**X**	**10'**	**X**	**10'**	**X**	**.33'**	**/ 27**	**=**	**3.83**

6.4 WHAT IS THE DIAMETER OF A CIRCLE, IF THE AREA IS 4.86 SQUARE FEET.

DIAMETER = $\sqrt{}$ ((AREA x 4) ÷ 3.14)
$\sqrt{}$ ((4.86 x 4) ÷ 3.14)
$\sqrt{}$ (19.44 ÷ 3.14)
$\sqrt{}$ 6.191
2.48'

OR, YOU MAY EXPRESS THE FORMULA LIKE THIS:

$$\text{DIAMETER} = \frac{(\text{AREA X } 4)}{3.14} = \sqrt{\frac{(4.86 \text{ X } 4)}{3.14}} = \sqrt{}6.191 = \mathbf{2.48'}$$

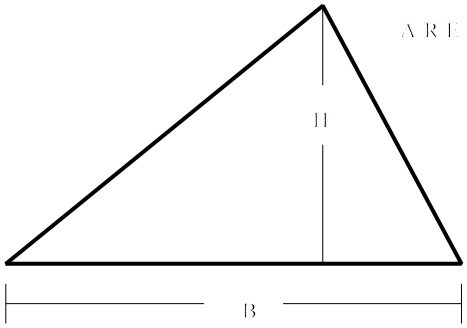
6.5 FORMULAS FOR A CIRCLE WITH A

VARIABLE CIRCUMFERENCE:

$$3.14 \times D' \times \frac{X^\circ}{360} = \text{LENGTH}$$

AREA:

$$3.14 \times R' \times R' \times \frac{X^\circ}{360} = \text{SQUARE FEET}$$



AREA = BASE X HEIGHT / 2 OR .5 X B X H

AREA X DEPTH = VOLUME (CUBIC)

7. **TRIANGLES**

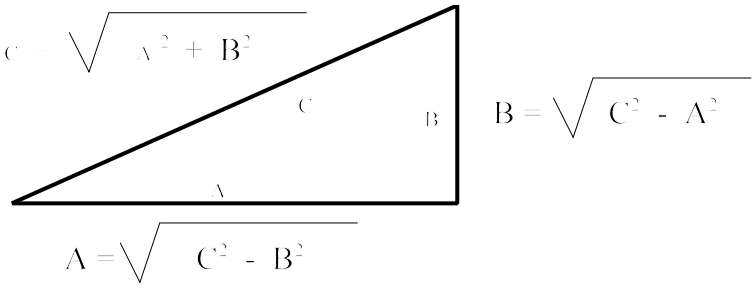
7.1 THERE ARE ___?___ SQUARE FEET CONTAINED IN A TRIANGULAR AREA MEASURING 77'- 6" AT THE BASE AND 45'- 3" AT THE HEIGHT.

SOLUTION: AREA = .5 X B X H
.5 X 77.5' X 45.25' = 1,753.4 SF

7.2 GIVEN A DEPTH OF 10" THROUGHOUT, THE SAME TRIANGULAR AREA WOULD CONTAIN _____?_____ CUBIC YARDS OF MATERIAL.

SOLUTION: AREA X DEPTH = CUBIC FEET / 27 = CUBIC YARDS
1,753.4 X .83' = 1,455.3 / 27 = 53.9

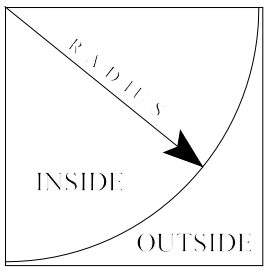
FINDING RIGHT TRIANGLE LEG LENGTHS



7.3 LENGTH “C” WILL BE ___?___ , IF SIDE “A” IS 100'- 0" AND SIDE “B” IS 20'- 0".

SOLUTION: $C = \sqrt{A^2 + B^2}$
$C = \sqrt{(100 \times 100) + (20 \times 20)}$
$C = \sqrt{10{,}000 + 400}$
$C = \sqrt{10{,}400}$, PRESS THE SQUARE ROOT KEY, C = 101.98'

8. **CORNERS**



TO FIGURE INSIDE AREA
R^2 X .785 = AREA

TO FIGURE OUTSIDE AREA
R^2 X .215 = AREA

NOTE:78.5% IS THE INSIDE, 21.5% IS THE OUTSIDE

8.1 THE AREA CONTAINED WITHIN AN INSIDE CORNER IS ___?___ SQUARE FEET, IF THE RADIUS IS 10 FEET.

SOLUTION: AREA = R^2 X .785

R	X	R	X	.785	=	AREA
10'	**X**	**10'**	**X**	**.785**	**=**	**78.5 SF**

8.2 THE AREA CONTAINED WITHIN AN OUTSIDE CORNER IS ___?___ SQUARE FEET, IF THE RADIUS IS 25 FEET.

SOLUTION: AREA = R^2 X .215

R	X	R	X	.215	=	AREA
25'	**X**	**25'**	**X**	**.215**	**=**	**134.37 SF**

8.3 A PLAN DETAIL INCLUDES A 50' RADIUS FOR ALL FOUR OUTSIDE CORNERS. THE AREA OF THE OUTSIDE CORNERS WILL BE _____?_____ SQUARE FEET.

SOLUTION: AREA = R^2 X .215

R	X	R	X	.215	=	AREA	X	4	= TOTAL
50'	**X**	**50'**	**X**	**.215**	**=**	**537.5**	**X**	**4**	**= 2,150 SF**

9 PROPORTIONS

SET CORRESPONDING ITEMS ACROSS FROM EACH OTHER
SET LIKE ITEMS ABOVE AND BELOW EACH OTHER

ITEM	ITEM
UNKNOWN	ITEM

RULE: CROSS MULTIPLY THE 2 DIAGONAL ITEMS. THEN DIVIDE BY THE REMAINING ITEM. ANSWER IS THE UNKNOWN

9.1 IF IT TAKES 1.5 CUBIC YARDS OF SAND FOR EVERY 80 SQUARE YARDS OF WALL AREA, ____?___ CUBIC YARDS OF SAND WILL BE REQUIRED FOR 450 SQUARE YARDS OF WALL AREA.

SAND	WALL
1.5	80
SAND	WALL
?	450

1.5 X 450 / 80 = 8.43 CUBIC YARDS

9.2 A 12' HIGH CYLINDRICAL WATER TANK HOLDS 3,200 GALLONS WHEN FULL. IF THE WATER LEVEL IS 1.5' HIGH, THERE WILL BE _?_ GALLONS OF WATER

HEIGHT	GALLONS
12'	3,200
HEIGHT	GALLONS
1.5'	?

1.5 X 3,200 / 12 = 400 GALLONS

9.3 A ROOFER USED 2 1/2 LBS. OF NAILS TO INSTALL 1.5 SQUARE OF SHINGLES, THE ESTIMATOR CALCULATED THE NUMBER OF REMAINING SQUARES TO BE 47 2/3. THE ROOFER WILL NEED __?__ LBS. OF NAILS TO FINISH THE JOB.

NAILS	SQUARE
2.5	1.5
NAILS	SQUARE
?	47.67

2.5 X 47.67 / 1.5 = 79.45 LBS.

10. **NUMBER OF ITEMS REQUIRED FOR EQUAL SPACING**

LENGTH IN FEET / SPACING IN FEET + 1 = MEMBERS REQUIRED (ROUND UP)

10.1 STUDS ARE TO BE SPACED 24"o.c. IN A WALL THAT MEASURES 100' IN LENGTH, THE NUMBER OF VERTICAL STUDS REQUIRED WOULD BE __?__ .

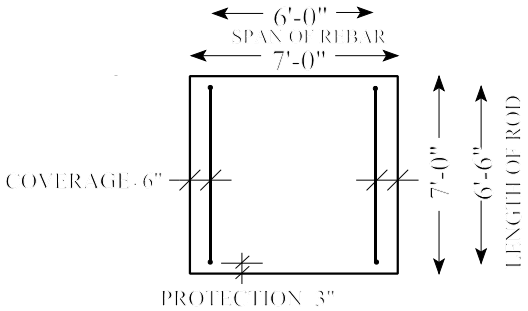
SOLUTION:	L'	/	SPACING'	+	1	=	NUMBER
	100'	**/**	**2'**	**+**	**1**	**=**	**51**

10.2 STUDS ARE TO BE SPACED 16"o.c. IN A WALL THAT MEASURES 75' IN LENGTH, THE NUMBER OF VERTICAL STUDS REQUIRED WOULD BE __?__ .

SOLUTION:	L'	/	SPACING'	+	1	=	NUMBER
	75'	**/**	**1.33'**	**+**	**1**	**=**	**57.39 OR 58**

10.3 REFER TO THE EQUIPMENT PIT FLOOR SLAB SHOWN. THE PIT WOULD REQUIRE ___?___ LINEAL FEET OF REBAR IN THE FLOOR SLAB ONLY, BASED ON THE FOLLOWING SPECIFICATIONS.

5 REBAR
6" O.C.E.W. SPACING
3" PROTECTION
6" COVERAGE



EQUIPMENT PIT FLOOR LAY-OUT

STEP 1. SUBTRACT THE COVERAGE AND USE THE EQUAL SPACING FORMULA TO FIND THE NUMBER OF ROD REQUIRED.

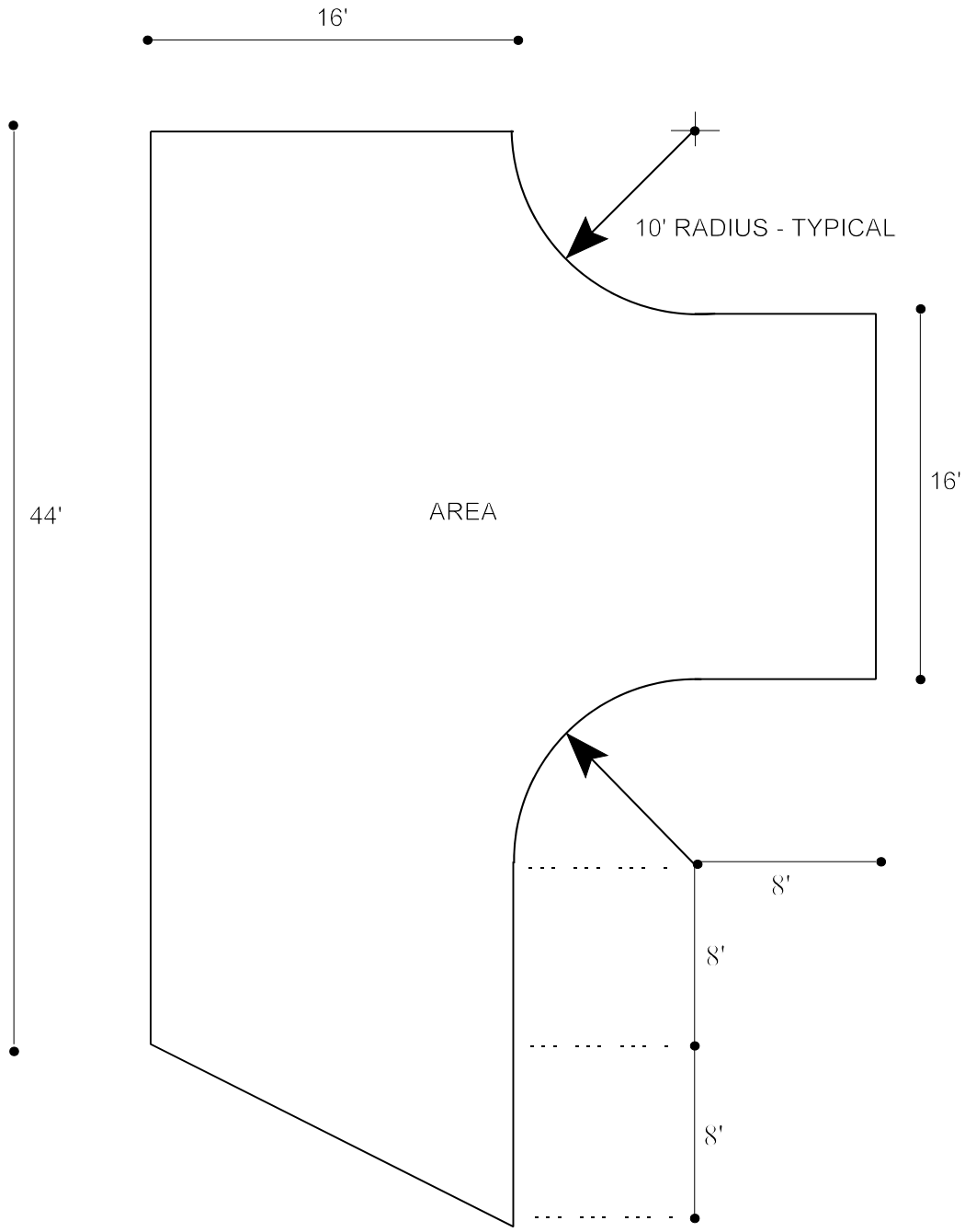
LENGTH '	/	SPACING '	+ 1	= NUMBER OF RODS
6'	**/**	**.5'**	**+ 1**	**= 13 RODS**

STEP 2. SUBTRACT THE PROTECTION AND FIND THE LENGTH OF THE RODS.

7'- 0" - 0.25' - 0.25' = 6.5'

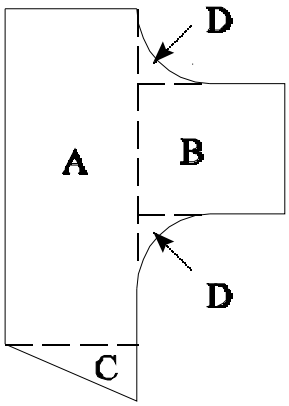
STEP 3. **13 RODS X 6.5' LENGTH = 84.5' ONE LAYER**
NOTE: 2 LAYERS = 1 MAT **+ 84.5' OTHER LAYER**
169.0' TOTAL PER MAT

11 **REFER TO THE AREA EXERCISE DRAWING BELOW**



11.1 THERE ARE ____?____ TOTAL SQUARE FEET OF AREA TO BE ESTIMATED.

BREAK DOWN AREA INTO GEOMETRIC SHAPES THAT CAN BE ESTIMATED " WHAT IS THERE "



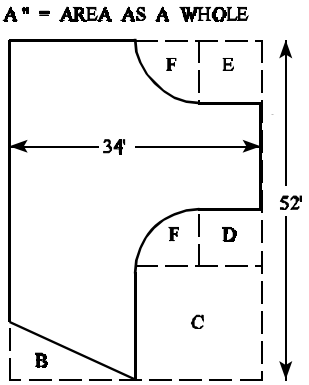
SOLUTION:

		L'	X	W'	=	SF	
A		16'	X	44'	=	704	M+
B		18'	X	16'	=	288	M+
C	.5 X	8'	X	16'	=	64	M+
D	2 X 10' X	10'	X	.215	=	43	M+
			TOTAL			**1,099**	MR

11.2 THERE ARE ____?____ TOTAL SQUARE FEET OF AREA TO BE ESTIMATED.

AREA AS A WHOLE, MINUS GEOMETRIC SHAPES " WHAT IS NOT THERE "

SOLUTION:



		L'	X	W'	=	SF	
A		34'	X	52'	=	1,768	M+
<B>	.5 X	8'	X	16'	=	< 64 >	M-
<C>		18'	X	16'	=	< 288 >	M-
<D>		8'	X	10'	=	< 80 >	M-
<E>		8'	X	10'	=	< 80 >	M-
<F>	2 X 10' X	10'	X	.785	=	< 157 >	M-
			TOTAL			**1,099**	MR

11.3 THE AREA HAS ___?___ LINEAR FEET AROUND IT'S ENTIRE PERIMETER.

SOLUTION: CALCULATE STRAIGHT, CURVED AND ANGLED LINEAL FEET.

STRAIGHT	ADD TOGETHER	44' + 16' + 8' + 16' + 8' + 8' + 8' = 108.00'
RADIUS (2 - 1/4 CIRCLES EQUAL 1/2 CIRCLE)	.5 X 3.14 X 10' X 2 =	31.40'
ANGLED	$C = \sqrt{A^2 + B^2}$	$\sqrt{(16 \times 16) + (8 \times 8)} = \sqrt{320} =$ 17.88'
		157.28'

12. **REFER TO THE PLAN DETAIL WITH A RADIUS SHOWN BELOW.**

12.1 THE WIDTH OF THE AREA SHOWN IS ____?____ FEET.

SOLUTION: 30' RADIUS - 14' RADIUS = **16'** (WIDTH)

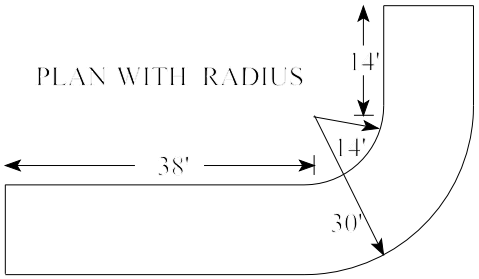
12.2 THE CENTERLINE LENGTH OF THE AREA WOULD BE ____?____ FEET.

SOLUTION:

STRAIGHT LENGTH (FROM PLAN)	38' + 14'	=	52.00'
CURVED LENGTH	.25 X 3.14 X 22' X 2	=	34.54'
			86.54'

*NOTE: THE CENTERLINE LENGTH OF THE 1/4 BEND IN THE DETAIL IS 1/4 OF THE CIRCUMFERENCE OF A CIRCLE, BASED ON THE **CENTERLINE RADIUS.***

FORMULA: .25 X 3.14 X " THE CENTERLINE RADIUS" X 2



12.3 USING THE WIDTH AND CENTERLINE LENGTH OBTAINED ABOVE, THE AREA WOULD CONTAIN _____?_____ SQUARE FEET.

SOLUTION:

L'	X	W'	=	SF
86.54'	**X**	**16'**	**=**	**1,384.6**

12.4 THE AREA SHOWN ABOVE WOULD REQUIRE ___?___ CUBIC YARDS OF MATERIAL, IF IT'S THICKNESS IS 5 INCHES.

SOLUTION:

L'	X	W'	X	D'	/	27	=	CY
86.54'	**X**	**16'**	**X**	**.416'**	**/**	**27**	**=**	**21.33**

13. **RECIPROCAL NUMBERS**

RECIPROCAL NUMBERS ARE WIDELY USED IN CONSTRUCTION. MOST OF US USE THEM WITHOUT EVEN KNOWING IT. FOR INSTANCE, AN INSULATION "U" VALUE IS A RECIPROCAL OF THE "R" FACTOR. WE ALSO USE RECIPROCALS IN ESTIMATING ALL THE TIME. FOR INSTANCE TO OBTAIN THE NUMBER OF STUDS SPACED 2' ON-CENTER, IN A 20' LONG WALL, WE COULD APPLY THE FOLLOWING FORMULA: *(ignore the extra stud for this example only)*

20' ÷ 2 = **10 STUDS**

OR, YOU CAN FIND THE RECIPROCAL NUMBER AND MULTIPLY INSTEAD OF DIVIDING. FIRST, FIND THE RECIPROCAL:

$$\frac{1}{2} = .5$$

NEXT, MULTIPLY BY THE RECIPROCAL, 20 x .5 = **10 STUDS -*SAME ANSWER!***

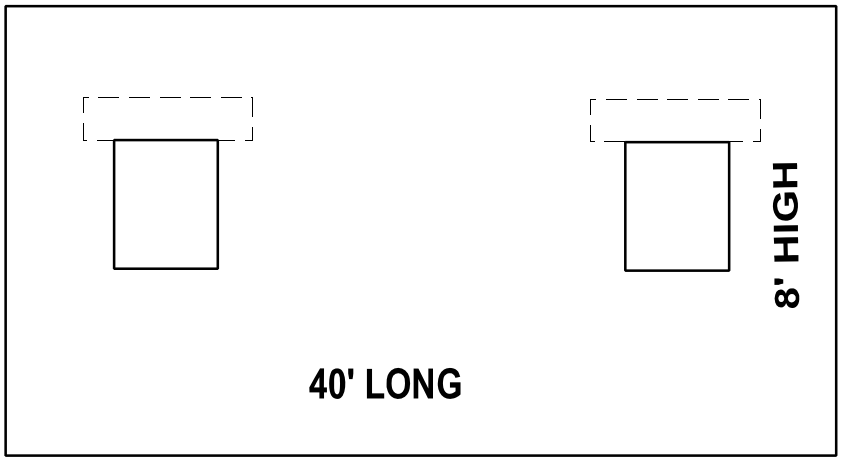
IF YOU CAN DIVIDE BY A NUMBER, YOU CAN MULTIPLY BY ITS RECIPROCAL

13.1 FIND THE RECIPROCAL NUMBER FOR STUDS SPACED 16" ON CENTER:
1 / 1.33 = .75 OR 12 / 16 = .75

13.2 FIND THE RECIPROCAL FOR 6" x 6" FLOOR TILE: 6" X 6" = 36 SQ. IN.
36 / 144 = .25 1 / .25 = 4

SINCE MULTIPLICATION IS THE EASIEST ESTIMATING METHOD, MOST BOOKS USE RECIPROCAL NUMBER TO PROVIDE FACTORS THAT CAN MULTIPLIED BY TO OBTAIN A REQUIRED QUANTITY. LOOK AT THE NEXT PROBLEM AND SEE HOW A RECIPROCAL FACTOR CAN BE USED IN OBTAINING THE REQUIRED QUANTITY OF CEMENT BLOCKS (CMU'S)

14. **REFER TO THE MASONRY WALL DRAWING SHOWN BELOW.**



14.1 THE WALL WOULD REQUIRE ___?___ 8" X 8" X 16" C.M.U., IF EACH WINDOW OPENING IS 3 FOOT X 4 FOOT IN SIZE AND HAS AN 8" HIGH LINTEL WITH 8" BEARING ON EACH END PLACED ABOVE.

SOLUTION: *THERE ARE 1.125 BLOCK PER SF OF WALL AREA (144 / 128)*
WIDTH ALWAYS PRECEDES HEIGHT (3' WIDE X 4' HEIGHT)

		L'	X	W'	=	SF	X	1.125	= BLOCK
		L'	X	W'	=	SF			
WALL AREA		40'	X	8'	=	320.00 M+			
<WINDOWS>	2 X	3'	X	4'	=	< 24.00 > M-			
<LINTELS>	2 X	[1] 4.33'	X	.67'	=	< 5.80 > M-			
				MR		**290.20**	**X**	**1.125**	**= 326.47**

[1] 3' WIDE + .67' (8" BRG.) + .67' (8" BRG.) = 4.33' (LENGTH OF LINTEL)

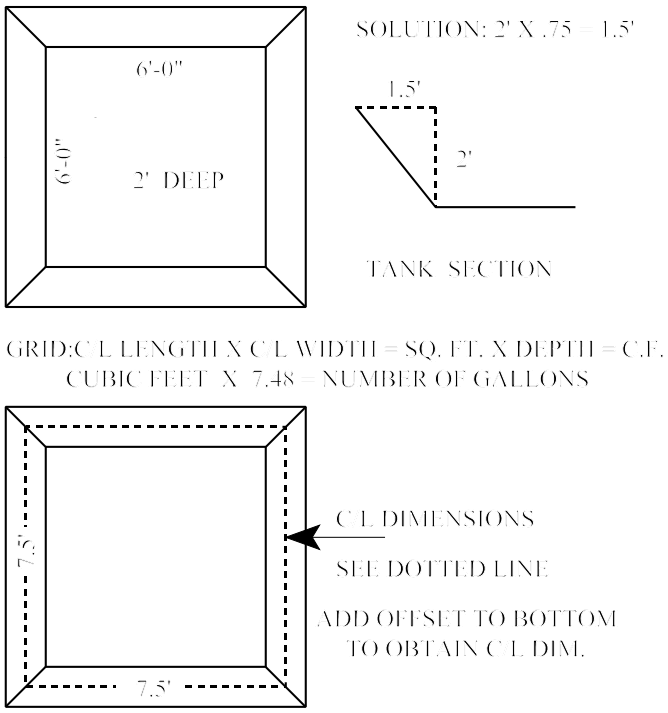
15. **SLOPED CALCULATIONS**

A SQUARE TANK IS TO BE CONSTRUCTED OUT OF 16 GA. STEEL. THE SIDES OF THE TANK ARE TO BE SLOPED AT AN ANGLE OF 53^0 OR 3/4 TO 1.

NOTE: 3/4 IS THE HORIZONTAL OFFSET AND 1 IS VERTICAL

15.1 THE TANK WILL CONTAIN ___?___ GALLONS OF WATER WHEN FULL.

15.2 IT TAKES ___?___ SQUARE FEET OF STEEL FOR THE BOTTOM AND 4 SIDES.

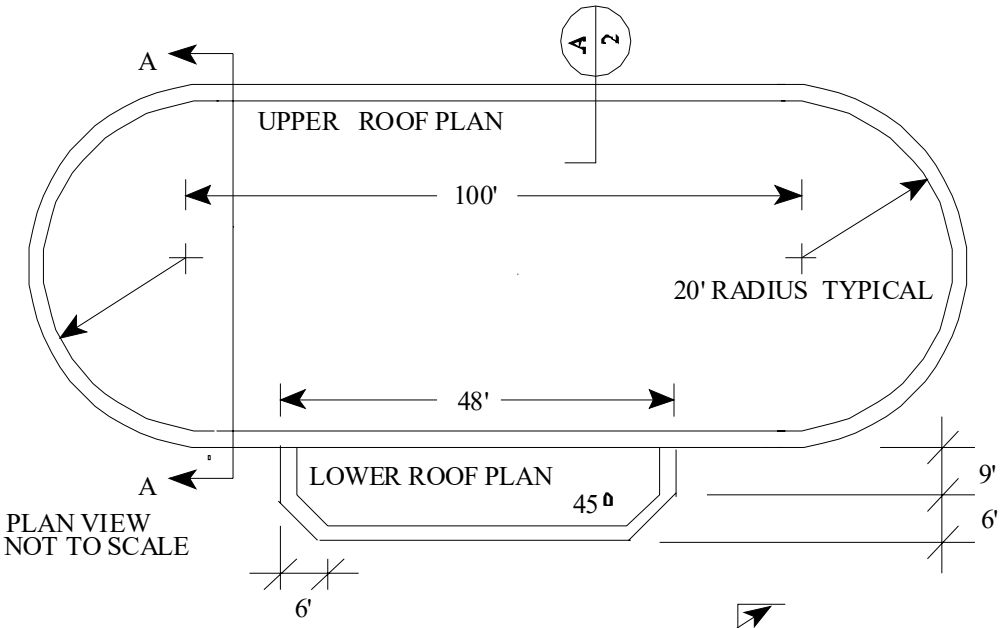


15.1 C/L LENGTH X C/L WIDTH = SF X DEPTH = CF X 7.48 = GALLONS
7.5' X 7.5' = 56.25 X 2' = 112.5 X 7.48 = 841.5

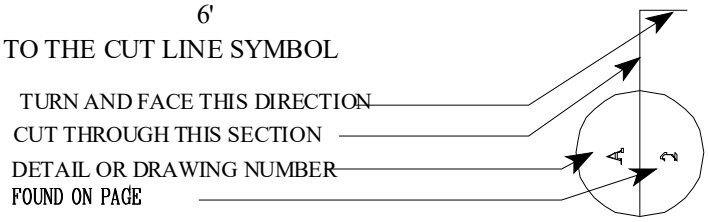
15.2	L'	X	W'	=	SF
BOTTOM	**6'**	**X**	**6'**	**=**	**36.0**
4 SIDES	**[1] 30'**	**X**	**[2] 2.5'**	**=**	**75.0**
	TOTAL				**111.0 SF**

* [1] 7.5' + 7.5' + 7.5' + 7.5' = 30' CENTERLINE OR AVERAGE LENGTH
* [2] C = THE SQUARE ROOT OF $A^2 + B^2$ $\sqrt{}(2 \text{ X } 2) + (1.5 \text{ X } 1.5) = \sqrt{}6.25 = 2.5'$

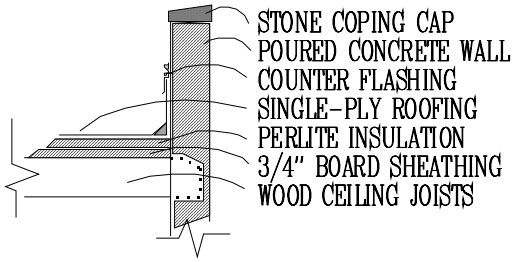
16. **GENERAL BLUEPRINT READING**



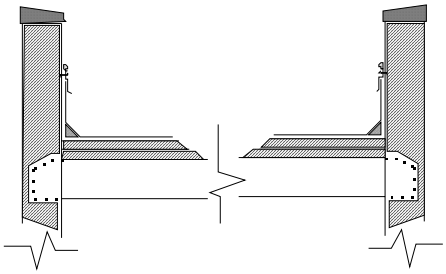
REFER TO THE CUT LINE SYMBOL



IF YOU WERE TO TURN TO PAGE 2 ON THE BLUE PRINTS, YOU WOULD FIND THAT DRAWING NUMBER "A" WOULD LOOK LIKE THIS:



REFER TO THE SECTION VIEW "A - A". THESE VIEWS USUALLY ARE FOUND ON AN ADJACENT PAGE TO THE DRAWING, THE SECTION VIEW WOULD LOOK LIKE THIS:



17. **STRETCH OUT OR GIRTH**

17.1 IT WOULD REQUIRE A MINIMUM OF _____?_____ SHEETS OF 4' X 10' METAL FOR THE FABRICATION OF METAL COPING CAP ON THE UPPER ROOF PLAN AREA, IF METAL COPING IS TO BE USED IN LIEU OF THE STONE COPING. ASSUME THE STRETCHOUT (GIRTH) OF THE METAL TO BE 16", AND THE PARAPET WALL IS TO BE 8" IN THICKNESS.

STEP 1. 48" WIDE METAL / 16" GIRTH = 3 RIPS PER SHEET.
3 RIPS X 10' LENGTH = 30 LINEAL FEET PER SHEET.

STEP 2. ESTIMATE STRAIGHT LENGTH: 100' + 100' = 200.00 L.F.
FIND C/L RADIUS LENGTH: (20' + .33' = 20.33')
CIRCUMFERENCE OF CIRCLE 3.14 X 20.33' X 2 = 127.67 L.F.
TOTAL 327.67 L.F.

STEP 3. **327.67' / 30' = 10.92 SHEETS**

18. **AVERAGE GRADE OR ELEVATION**

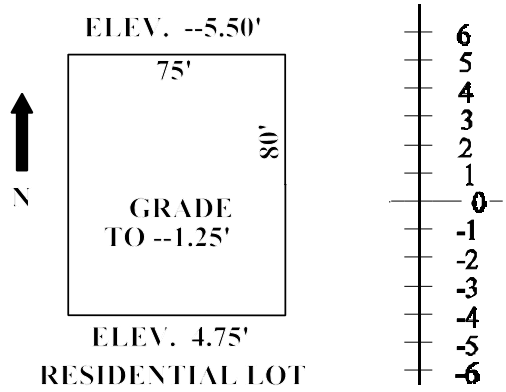
18.1 BASED ON THE FOUR ELEVATIONS GIVEN, THE AVERAGE GRADE OF THE FOLLOWING LOT WOULD BE ___?___ .

SOLUTION: ADD THE FOUR ELEVATIONS, DIVIDE BY 4 = AVERAGE GRADE

21.09' + 19.56' + 32.76' + 35.27' = 108.68 / 4 = **27.17' AVERAGE LOT ELEVATION**

19. **SLOPES WITH NEGATIVE ELEVATIONS**

19.1 THE LOT SHOWN WOULD REQUIRE ___?___ CUBIC YARDS OF CUT OR FILL.



NOTE: TO DETERMINE THE AMOUNT OF CUT (REMOVED) OR FILL (ADDED), YOU WILL NEED TO KNOW WHAT YOU HAVE **(AVG. GRADE)** AND COMPARE THAT TO WHAT YOU NEED. **(FINISH GRADE)**

L' X W ' = SF X **D'** / 27 = CY
↑
THE UNKNOWN IS THE *DEPTH*

STEP 1. FIND THE LOWEST NEGATIVE ELEVATION IN THE PROBLEM, ADD THIS TO ALL ELEVATIONS GIVEN IN THE PROBLEM. ADJUSTING ALL NUMBERS WILL GET RID OF THE NEGATIVE.

(LOWEST) EXIST. NORTH ELEV. -5.50' + 5.50' = 0.00' NEW NORTH ELEV.
DESIRED GRADE -1.25' + 5.50' = **4.25' NEW FINISH GRADE**
EXIST. SOUTH ELEV. 4.75' + 5.50' = 10.25' NEW SOUTH ELEV.

STEP 2. OBTAIN THE RISE AND RUN TO FIND THE AVERAGE GRADE:

RISE = 10.25' RUN = 80'

SOLVE BY PROPORTION.

RISE	RUN
10.25'	80'
RISE	RUN
?	40'

10.25' IS TO 80', AS __?__ IS TO 40'
10.25 X 40 / 80 = **5.12' RISE**

"THE AVERAGE GRADE IS THE CENTER OF THE LOT"

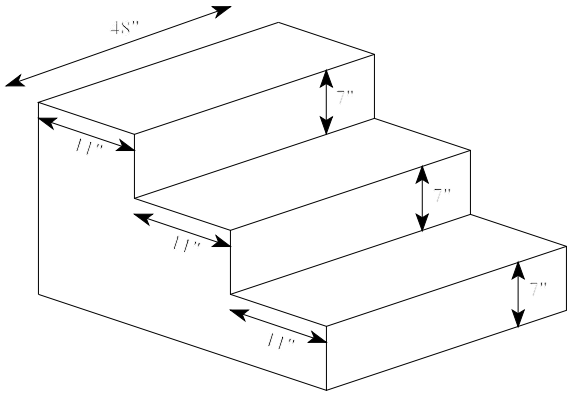
ADD THE RISE TO THE LOW SIDE ELEVATION 0.00' + 5.12' = 5.12' AVG. GRADE

STEP 3. TO FIND THE AMOUNT OF CUT OR FILL, YOU MUST COMPARE
WHAT YOU HAVE 5.12' - WHAT YOU NEED 4.25' = .87' (CUT)

L'	X	W'	=	SF	X	D'	/	27	=	CY
75'	X	80'	=	6,000	X	**.87'**	/	27	=	**193.33**

NOW, YOU HAVE THE DEPTH ↑ (CUT)

20. **CONTACT AREA AND VOLUME**



20.1 THE STEPS ARE 4' IN LENGTH AND HAVE UNIFORM 11" TREADS AND 7" RISERS. THE CONTACT AREA OF THE FORMWORK IS ___?___ SQUARE FEET.

FIND END AREA	L"	X	W"	=	SQUARE INCHES / 144 = SF
	11"	X	21"	=	231 M+
	11"	X	14"	=	154 M+
	11"	X	7"	=	77 M+
				MR	462 SI / 144 = 3.20 X 2 = 6.40 SF

(ONE END = OTHER END)

FIND BACK AREA	L"	X	W"	=	SQUARE INCHES / 144 = SF
	21"	X	48"	=	1,008 SI / 144 = 7.0 X 2 = 14 SF

(FRONT AREA = BACK AREA)

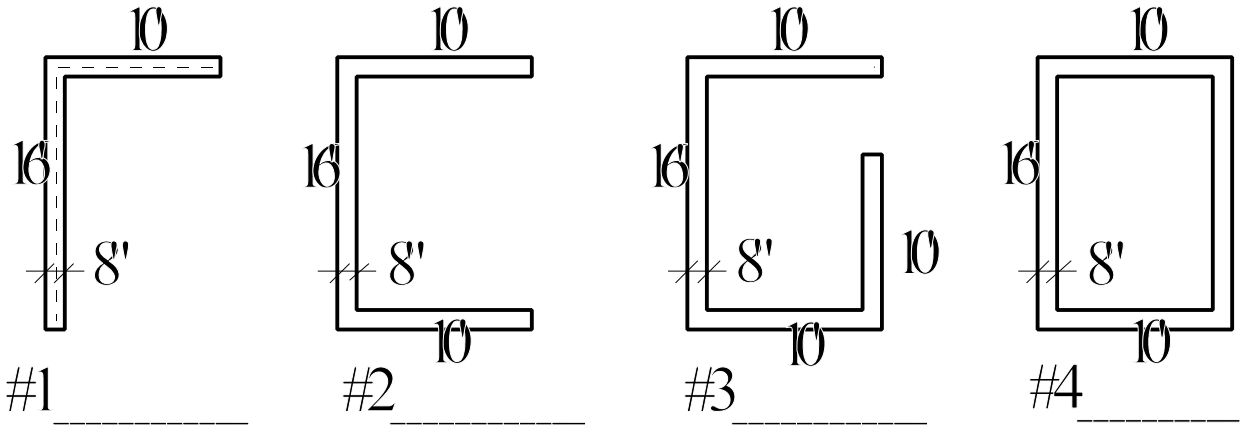
6.40 SF (2 ENDS) + 14 SF (FRONT + BACK) = 20.40 SF CONTACT AREA

20.2 THE TOTAL VOLUME OF CONCRETE REQUIRED TO POUR THE ENTRY STEPS WOULD BE ___?___ CUBIC YARDS.

END AREA, FROM ABOVE PROBLEM (NOW SHOWN IN FEET)

L'	X	W'	=	SF	X	D'	/	27	=	CY
.916'	X	1.75'	=	1.603	M+					
.916'	X	1.16'	=	1.063	M+					
.916'	X	.583'	=	.534	M+					
			MR	3.200	X	4'	/	27	=	**.47 CY**

21. DETERMINE THE CENTERLINE LENGTH OF THE PLANTERS SHOWN.



DEDUCT THE NUMBER OF CORNERS TIMES THE THICKNESS OF THE WORK *(WHEN VIEWED FROM ABOVE)* FROM THE OUTSIDE DIMENSIONS, OR ADD THE NUMBER OF CORNERS TIMES THE THICKNESS OF THE WORK *(WHEN VIEWED FROM ABOVE)* TO THE INSIDE DIMENSIONS. THIS WILL GIVE YOU THE ACTUAL CENTERLINE DIMENSION FOR ACCURATE ESTIMATING.

CENTERLINE RULE: *ADD OR SUBTRACT 4 TIMES THE THICKNESS FOR C/L*

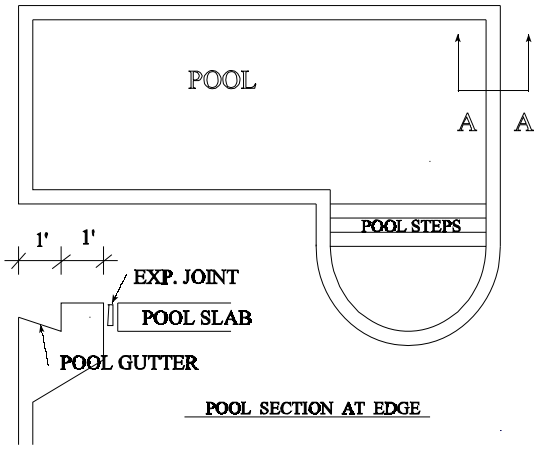
ANSWER TO 1.	26' - (1 CORNER X .67' = .67')	= 25.33'
ANSWER TO 2.	36' - (2 CORNERS X .67' = 1.34')	= 34.66'
ANSWER TO 3.	46' - (3 CORNERS X .67' = 2.00')	= 44.00'
ANSWER TO 4.	52' - (4 CORNERS X .67' = 2.68')	= 49.32'

21.3 REFER TO THE POOL SECTION AND PLAN SHOWN BELOW:

THE INSIDE POOL PERIMETER IS GIVEN AS 210 L.F. HOW MANY LINEAL FEET OF EXPANSION JOINT WILL BE REQUIRED.

210' + (4 CORNERS X [1] 4' = 16') = 226 L.F.

[1] THE THICKNESS THE WORK WOULD HAVE BEEN, IF THE EXPANSION JOINT WAS THE CENTERLINE. (4 FOOT)



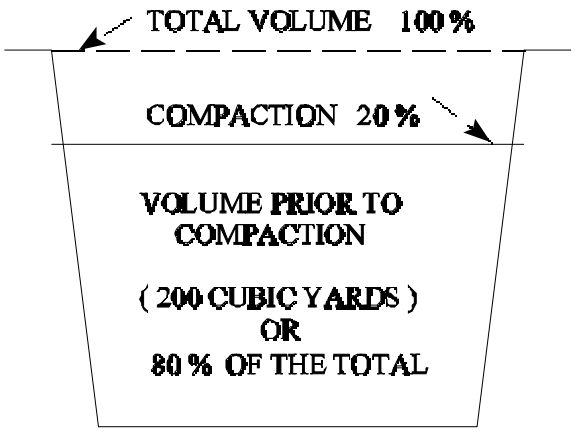
22.COMPACTION AND SWELL

22.1 COMPACTION: FIGURED BY PROPORTION

WITH NO ALLOWANCE FOR COMPACTION, A PROJECT REQUIRES 200 CUBIC YARDS OF FILL. A CONTRACTOR SHOULD ORDER ___?___ CUBIC YARDS OF FILL, IF THE FILL IS TO BE COMPACTED 20%.

CY	%
200	80%
CY	%
?	100%

200 X 100 / 80 = 250 CUBIC YARDS



22.2 SWELL: SIMPLY ADD THE EXTRA PERCENTAGE GIVEN.

IF THE IN-BANK QUANTITY TO BE EXCAVATED IS 200 CUBIC YARDS, A CONTRACTOR CAN EXPECT TO HAUL ___?___ CUBIC YARDS FROM THE PROJECT IF THE EARTH SWELLS 20% WHEN EXCAVATED.

200 X 1.20 = 240 CUBIC YARDS

23. PERCENT CALCULATIONS

A PERCENT IS PART OF A FRACTION WITH THE "DENOMINATOR" OF 100.

FOR INSTANCE: 20% MEANS 20 / 100 OR .20 IN DECIMAL FORM

23.1 PERCENTS CAN BE USED IN 2 DIFFERENT WAYS: IF YOU WERE TO FIGURE WORKMAN'S COMPENSATION ON A $ 6,000.00 JOB, AND THE RATE WAS 20%, THE AMOUNT DUE WOULD BE ___?___ .

USING THE PERCENT KEY:	$ 6,000.00 X 20%	$ 1,200.00
OR IN DECIMAL FORM:	$ 6,000.00 X .20 =	$ 1,200.00

TO ADD 20% OR .20 TO A NUMBER, PUT A "1" IN FRONT OF THE DECIMAL:	$6,000.00 x 1.20 =	$7,200.00

ADDING PERCENTS USING THE % KEY ON YOUR CALCULATOR MAY REQUIRE DIFFERENT KEYSTROKES FOR DIFFERENT CALCULATORS. ALL CALCULATORS WORK THE SAME USING THE DECIMAL FORM. THEREFORE, ALL OUR PERCENTAGE CALCULATIONS IN THE COURSE MATERIALS WILL USE THE DECIMAL FORM.

REMEMBER THAT TO CHANGE ANY PERCENT TO A DECIMAL FORM, DIVIDE BY 100, OR JUST MOVE THE DECIMAL 2 PLACES TO THE LEFT AND DROP THE PERCENT SIGN. FOR EXAMPLE: 43% IS THE SAME AS .43 , JUST MOVE THE DECIMAL POINT 2 PLACES TO THE LEFT.

TO CHANGE A DECIMAL FORM TO A PERCENT, MULTIPLY BY 100, OR JUST MOVE THE DECIMAL 2 PLACES TO THE RIGHT AND ADD A PERCENT SIGN. FOR EXAMPLE: .30 IS 30%

23.2 YOU CAN USE THIS INFORMATION TO DETERMINE WHAT A NUMBER WAS BEFORE A PERCENT WAS ADDED. FOR INSTANCE, A BID WAS GIVEN TO AN OWNER FOR $350.00 THAT CONTAINED A 25% MARK-UP PROFIT. THE ACTUAL COST OF THE WORK WAS ___?___ .

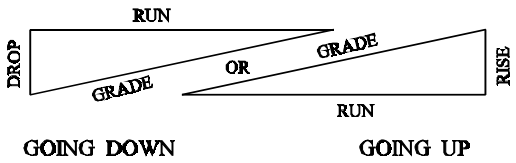
$ 350 / 1.25 = $ 280.00 COST - OR - $ 350 / 125 % = $ 280.00 COST

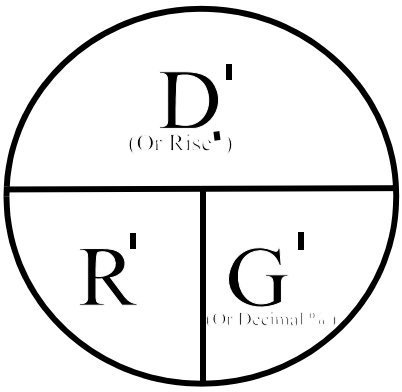
- OR -

COST $	%
?	100%
SELL $	%
350	125%

350 X 100 / 125 = $ 280.00 COST

24. **DROP, RUN AND GRADE**





GRADE X 100 = GRADE %

DOWN-RIGHT-GOOD

24.1 THE PERCENT GRADE OF A LOT IS ____?____ , IF THE LOT DROPS 8" IN 60'.

ANSWER: .67' / 60' = .011' X 100 = 1.1%

24.2 THE GRADE TO THE CLOSEST 1/16" IS ____?____ , IF A PIPE DROPS 5" IN 22'.

ANSWER: .416' / 22' = .019' X 12 = .228", .228 X 16 = 3.6 OR 4/16 (1/4")

24.3 THE DROP IS ____?____ INCHES, IF AN 18' ROOF RUN SLOPES 1/4" PER FOOT.

ANSWER: 18' X .0208' = .375' X 12 = 4.5", .5" X 16 = 8/16 (4-1/2")

24.4 AN ARCHITECT SPECIFIED AN 8% GRADE FOR A HANDICAP RAMP. THE REQUIRED RUN OF THE RAMP IS ____?____ , IF THE RAMP RISE IS 2 FEET.

ANSWER: 2' / .08 = 25 FEET

25. BUILDER'S LEVEL / TRANSIT TERMINOLOGY

TARGET	A ROD, WITH A RULER GRADUATION SCALE USED TO DETERMINE MEASUREMENTS. (READINGS)
LINE OF SIGHT **L.O.S.**	THE IMAGINARY LINE FROM THE CROSS HAIRS IN THE BUILDERS LEVEL TO A POINT VIEWED ON THE TARGET.
TRIPOD	A STAND THAT THE BUILDERS LEVEL IS MOUNTED ON.
STATION	ANY POINT YOU ARE WORKING FROM, OR ANY POINT YOU ARE TRYING TO ESTABLISH OR VERIFY. THE POINT WHERE THE ASSISTANT PLACES AND HOLDS THE ROD.
STATION ELEVATION **S.E.**	ELEVATION OF THE STATION ABOVE A REFERENCE POINT THAT YOU ARE USING. USUALLY A STATION ELEVATION IS EXPRESSED IN HEIGHT ABOVE SEA LEVEL, BUT IT COULD BE ANY HEIGHT ABOVE OR BELOW A STARING POINT SUCH AS 0.00' OR 100.00'
BENCHMARK **B.M.**	A STATION OF KNOWN ELEVATION ESTABLISHED BY OTHERS. USUALLY A BENCHMARK IS EXPRESSED IN THE NUMBER OF FEET ABOVE SEA LEVEL.
BACKSIGHT **B.S.**	THE ROD MEASUREMENT OBTAINED BY THE LINE OF SIGHT. THE READING WHEN THE ROD IS HELD ON A GIVEN BENCHMARK OR STATION ELEVATION.
HEIGHT OF INSTR. **H.I.**	THE HEIGHT OF THE LINE OF SIGHT (L.O.S.) ABOVE THE BENCHMARK ELEVATION.
FORESIGHT **F.S.**	THE ROD MEASUREMENT OBTAINED BY THE LINE OF SIGHT. THE READING WHEN THE ROD IS HELD ON A STATION TO BE ESTABLISHED OR VERIFIED.
STATION SPACING	WHEN USING MULTIPLE FORESIGHT READINGS SUCH AS SIGHTING DOWN A LONG PIPE SECTION OR LOT LINE, STATIONS ARE LOCATED AND NUMBERED TO INDICATE POSITIONS ALONG THE PIPE. MAJOR SPACING DISTANCE IS ALWAYS 100 FEET. THE STARTING POINT IS ALWAYS STATION 0+00. STATION 0+50 IS 50 FEET AWAY AND STATION 2+35 IS 235' AWAY FROM THE STARTING POINT.

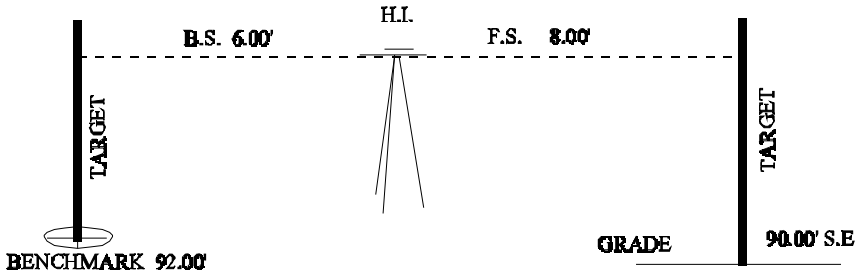
STATION ELEVATION FORMULA: B.M. + B.S. = H.I. - F.S. = STATION ELEV.

IF YOU NEED THE FORESIGHT ROD READING, SWITCH THE LAST PART OF THE FORMULA

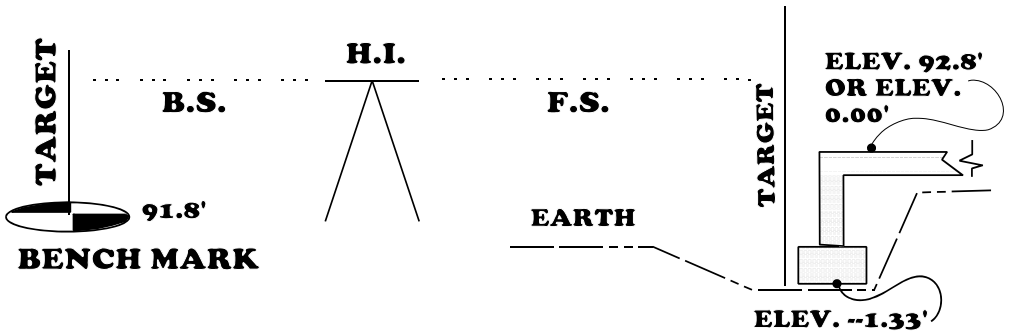
FORESIGHT READING FORMULA: B.M. + B.S. = H.I. - S.E. = F.S. READING

25.1 A CONTRACTOR WANTS TO DETERMINE THE SEA LEVEL ELEVATION OF THE SOUTHWEST CORNER OF A LOT. THE CONTRACTOR SETS UP A ROD ON THE BENCHMARK ELEVATION OF 92.00' AND TAKES A BACKSIGHT READING OF 6 FEET. THE CONTRACTOR THEN MOVES TO THE CORNER AND DETERMINES THE FORESIGHT ROD READING TO BE 8 FEET. THE SEA LEVEL ELEVATION OF THE LOT CORNER WOULD BE ____?____ .

SOLUTION:	**B.M.**	**+**	**B.S.**	**=**	**H.I.**	**-**	**F.S.**	**=**	**S.E.**
	92.00'	**+**	**6.00'**	**=**	**98.00'**	**-**	**8.00'**	**=**	**90.00'**



25.2 REFER TO THE DRAWING BELOW.



THE PROPER ROD READING (FORE SIGHT) TO ESTABLISH THE BOTTOM OF THE FOOTER WOULD BE _____, IF THE BACK SIGHT READING WAS 5.00'.

BM +	BS =	H.I. -	S.E. =	F.S.
91.8 +	5.00 =	96.8 -	[1]91.47 =	5.33'

[1] 92.8' FLOOR ELEVATION - SEA LEVEL
<1.33> STATION ELEVATION - ARCHITECTURAL (0.00')
91.47 STATION ELEVATION - SEA LEVEL

26. **INSULATION**

THE NEED FOR INSULATION IT IS COMPARATIVELY EASY TO HEAT OR COOL ENCLOSED SPACES. IT IS NOT EASY, HOWEVER, TO KEEP THEM AT A CONSTANT TEMPERATURE, THIS IS BECAUSE HEAT RISES, THEN TENDS TO FLOW FROM THE HIGHER (WARMER) AREAS TO LOWER (COOLER) AREAS.

IF YOU WERE TO KEEP A SPACE WITHIN A CERTAIN TEMPERATURE RANGE, IT IS NECESSARY TO PREVENT THE TRANSFER OF HEAT TO OR FROM THIS SPACE. FORTUNATELY, THIS CAN BE DONE SUCCESSFULLY BY THE USE OF A SUBSTANCE WITH "LOW THERMAL CONDUCTANCE".

INSULATORS SUBSTANCES THAT DO NOT CONDUCT HEAT WELL ARE "POOR CONDUCTORS", THEREFORE THEY WILL BE "GOOD INSULATORS".

POOR CONDUCTORS INCLUDE SUCH SUBSTANCES AS EXPANDED FOAM, ROCK WOOL, SPUN FIBERGLASS, RUBBER, WOOD, AND DEAD AIR SPACE. INSULATION EFFECTIVENESS IS RATED BY ITS RESISTANCE, CALLED: "R" FACTOR OR RATED BY A VALUE CALLED: "K", "C" OR "U".

WHEN DIFFERENT MATERIALS ARE PLACED TOGETHER

***VALUES*, K, C OR U CANNOT BE ADDED TOGETHER, THE LOWER, THE BETTER.**
***FACTORS,* SUCH AS R CAN BE ADDED TOGETHER, THE HIGHER, THE BETTER.**

CONDUCTIVITY, "K" VALUE THE "K" VALUE FOR AN INSULATING MATERIAL IS THE AMOUNT OF BTU, PER SQUARE FOOT, AT **1" THICKNESS**, PER HOUR, PER ^{0} F., THAT CAN BE TRANSMITTED THROUGH A MATERIAL.

CONDUCTANCE, "C" VALUE "C" VALUE IS THE "K" VALUE ADJUSTED FOR A THICKNESS OTHER THAN 1 INCH. IF A MATERIAL IS 1" THICK, THE "K" AND "C" WILL BE THE SAME. TO ADJUST TO A DIFFERENT THICKNESS, THE FOLLOWING FORMULA IS USED:

$$C = \frac{K}{\text{THICKNESS "}}$$

AGAIN, THE LOWER, THE BETTER.

RESISTANCE, "R" FACTOR "R" FACTORS ARE THE UNIT MOST PEOPLE ARE FAMILIAR WITH. THE HIGHER THE "R", THE BETTER THE INSULATION. AN "R" FACTOR IS A RECIPROCAL OF A VALUE. TO CONVERT AN R FACTOR FROM A VALUE, USE ONE OF THE FOLLOWING FORMULAS:

$$R = \frac{1}{K} \quad \text{OR} \quad R = \frac{\text{THICKNESS "}}{K} \quad \text{OR} \quad R = \frac{1}{C}$$

OVERALL COEFFICIENT "U" VALUE THE OVERALL COEFFICIENT, "U" VALUE IS THE OVERALL EFFECTIVENESS OF ALL THE COMPONENTS WORKING TOGETHER TO RESIST THERMAL HEAT TRANSFER.

OVERALL COEFFICIENTS ARE FOUND BY ADDING ALL OF THE "R" FACTORS TOGETHER, AND APPLYING THE FOLLOWING FORMULA FOR A "U" VALUE.

$$U = \frac{1}{R_{TOTAL}} \quad \textbf{OR} \quad R = \frac{1}{U}$$

"U" IS A VALUE, THEREFORE THE LOWER, THE BETTER.

GIVEN: THE RIGID INSULATION BOARD HAS A LISTED "K" VALUE OF .18 THE PROJECT WILL REQUIRE RIGID INSULATION BOARD 1-1/2" THICK.

26.1 THE "R" FACTOR OF THE PROJECT INSULATION WOULD BE ____?____ .

FORMULA: R = T" / K **SOLUTION: 1.5" / .18 = 8.33**

26.2 THE "C" VALUE FOR THE PROJECT INSULATION WOULD BE ____?____ .

FORMULA: C = K / T" **SOLUTION: .18 / 1.5" = .12**

26.3 IF A CHANGE ORDER FOR THE PROJECT INDICATED AN "R" FACTOR OF 14, THE INSULATION WOULD NEED TO BE ____?____ INCHES IN THICKNESS.

IF R = T" / K, THEN T" = R X K SOLUTION: 14 X .18 = 2.52"

26.4 IF A WALL SECTION HAS A COMBINED "R" FACTOR OF 14.17, THE "U" VALUE FOR THE WALL SECTION WOULD BE ____?____ .

FORMULA: $U = 1 / R_{TOTAL}$ **SOLUTION: 1 / 14.17 = .070**

27. CRITICAL PATH METHOD (C.P.M.) TERMINOLOGY AND DIAGRAM

EVENT THESE ARE THE NUMBERS IN THE MIDDLE OF THE CIRCLES. EVENTS ARE MILESTONES IN THE CONSTRUCTION PROCESS AND DO NOT REQUIRE ANY TIME. THEY ARE STAGES OF COMPLETION. *EXAMPLE: THE SLAB IS POURED, THE DRYWALL IS FINISHED, ETC.*

ARROW ARROW LINES CONNECT ALL EVENTS. THE TAIL OF THE LINE REPRESENTS THE START OF AN ACTIVITY (WORK ITEM), WHILE THE ARROWHEAD REPRESENTS COMPLETION OF THE ACTIVITY.

DUMMY A DUMMY LINE IS A DASHED ARROW LINE. THESE LINES CONNECT TWO EVENTS, BUT **DO NOT** REQUIRE ANY TIME. (DURATION IS "O") CONSIDER THE ACTIVITY "ROOF SHINGLES". BOTH DRY-IN PAPER AND THE PLUMBING VENTS MUST BE THROUGH THE ROOF PRIOR TO INSTALLING THE SHINGLES. THE 2 EVENTS; DRY-IN AND PLUMBING TOP-OUT WILL BE CONNECTED BY A DUMMY LINE. WHEN ADDING THE PROJECT DURATION, USE THE HIGHEST NUMBER OBTAINABLE FOR BOTH EVENTS TOUCHED BY THE DUMMY LINE.

ACTIVITY THESE ARE LETTERS (A, B, C, ...) FOUND ABOVE THE ARROW LINE. THE LETTERS ARE ASSIGNED TO ACTUAL WORK ITEMS THAT ARE TO BE DONE BETWEEN EVENTS. EXAMPLE; FORMING AND POURING OF CONCRETE, EXTERIOR WOOD FRAMING AND SETTING TRUSSES ARE EXAMPLES OF ACTIVITIES. AN ACTIVITY GENERALLY WILL REQUIRE SOME AMOUNT OF TIME TO PERFORM THE WORK.

DURATION THESE ARE NUMBERS BELOW THE ARROW LINE. A DURATION IS THE AMOUNT OF TIME (IN DAYS) REQUIRED TO COMPLETE AN ACTIVITY. IF THE ACTIVITY "DRYWALL" REQUIRES 10 DAYS TO HANG, FINISH AND SPRAY, THE ACTIVITY LETTER ASSIGNED TO DRYWALL WILL SHOW THE NUMBER 10 BELOW THE LINE. (10 DAYS DURATION)

L.S. LATE START. THE LATEST DAY THAT YOU CAN START AN ACTIVITY AND STILL MAINTAIN THE PROJECT SCHEDULE.

E.S. EARLY START. THE EARLIEST THAT YOU CAN START AN ACTIVITY WITHOUT CAUSING THE WORK TO BECOME OUT OF SEQUENCE.

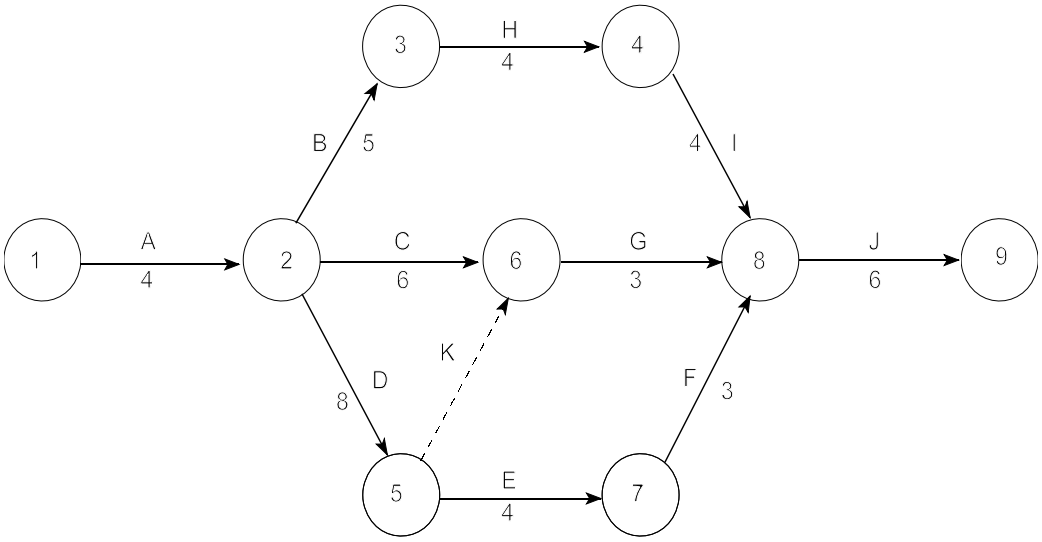
F.P. FORWARD PASS. THE DURATION OF A PROJECT IS OBTAINED BY GOING FORWARD THROUGH THE DIAGRAM ADDING TOGETHER THE MAXIMUM NUMBER OF DAYS FOR EACH ACTIVITY. THE LONGEST POSSIBLE PATH IS THE CRITICAL PATH. (BASIS OF CONTRACT TIME)

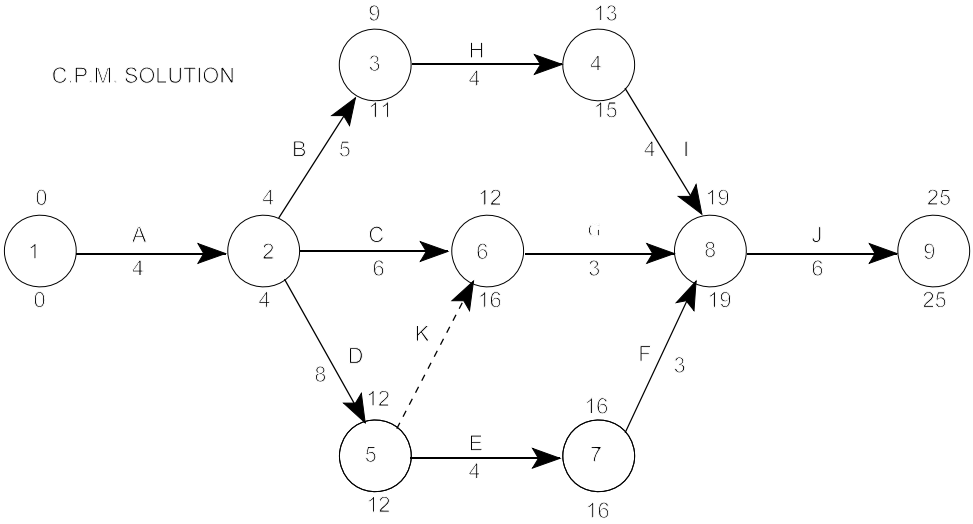
B.P. BACKWARD PASS. USED TO FIND THE LATE START OF ACTIVITIES. IT IS OBTAINED BY SUBTRACTING THE NUMBER OF DAYS OF EACH ACTIVITY GOING BACKWARDS THROUGH THE NETWORK DIAGRAM.

27.1 REFER TO THE DIAGRAM. CALCULATE THE TOTAL NUMBER OF DAYS TO COMPLETE THE PROJECT AND THE LATE START OF EACH ACTIVITY.

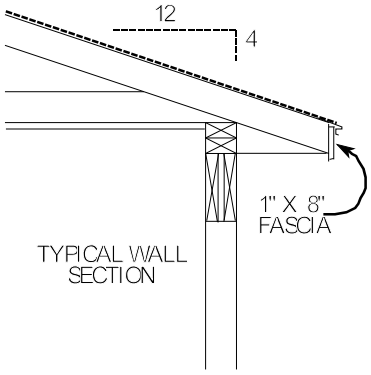
REMEMBER, *WHENEVER MORE THAN ONE ARROWHEAD TOUCHES AN EVENT, IT INDICATES ANOTHER PATH, COMPARE AND USE THE GREATER NUMBER OF DAYS.*

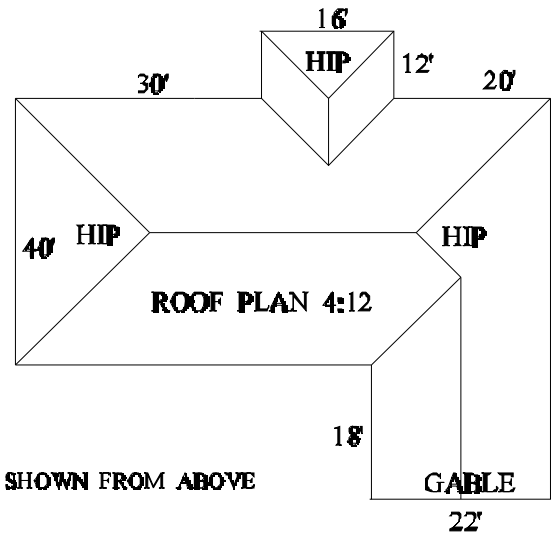
NOTE: THE LONGEST PATH IS THE CRITICAL PATH AND THE DIFFERENCE BETWEEN THE LATE START AND EARLY START IS THE FLOAT TIME OF EACH ACTIVITY.





28. **ROOF SLOPE FACTORS**





REFER TO THE ROOF DRAWING ABOVE AND ROOF AREA FACTOR TABLE BELOW:

RISE AND RUN	AREA OR RAKE MULTIPLY FLAT AREA OR GABLE SPAN BY:	HIP OR VALLEY LENGTH MULTIPLY THE SPAN OF THE HIP OR VALLEY RAFTER BY:
4 IN 12	1.054	1.453
5 IN 12	1.083	1.474

28.1 THE TOTAL NUMBER OF ROOFING SQUARES WOULD BE _____?_____ .

L' X W' = SF X FACTOR = ROOF SF / 100 = SQUARE

L' X W' = SF
66' X 40' = 2,640 M+
22' X 18' = 396 M+
16' X 12' = 192 M+
TOTAL MR **3,228 X 1.054 = 3,402 / 100 = 34.02 SQUARE**

28.2 THE ROOF SHOWN ABOVE HAS ___?___ LINEAL FEET OF HIP.

HORIZONTAL PROJECTION OF THE HIP RAFTER X FACTOR = LF OF HIP

20' X 1.453 = 29.06' X 3 HIPS = 87.18'
8' X 1.453 = 11.62' X 2 HIPS = 23.24'
9' X 1.453 = 13.07' X 1 HIP = 13.07' (DOGLEG HIP 20' - 11' = 9')
TOTAL HIPS **123.49' LINEAL FEET**

28.3 THE SAME ROOF HAS ____?____ LINEAL FEET OF VALLEY.

HORIZONTAL PROJECTION OF THE VALLEY RAFTER X FACTOR = LF OF VALLEY

11' X 1.453 = 15.98' X 1 VALLEY =		15.98'
8' X 1.453 = 11.62' X 2 VALLEYS =		23.24'
TOTAL VALLEY		**39.22' LINEAL FEET**

28.4 THE LENGTH OF RIDGE REQUIRED FOR THE ROOF WOULD BE ___?___ L.F.

NOTE: ALL HIPS AND VALLEYS ARE PLACED AT A 45^0 ANGLE.

(MAIN SPAN)	66' - 20' - 20'	= 26'
(BACK SPAN)		= 12'
(FRONT SPAN)	18' + 11'	= 29'
		67' LF OF RIDGE

28.5 THE GABLE END FASCIA REQUIRED FOR THE ROOF WOULD BE ___?___ L.F.

NOTE: RAFTER OR FASCIA LENGTH IS DETERMINED BY USING THE SAME FACTOR AS THE ROOF AREA FACTOR. EXAMPLE, 4:12, USE 1.054

HORIZONTAL PROJECTION OF GABLE X RAKE FACTOR = TRUE LENGTH

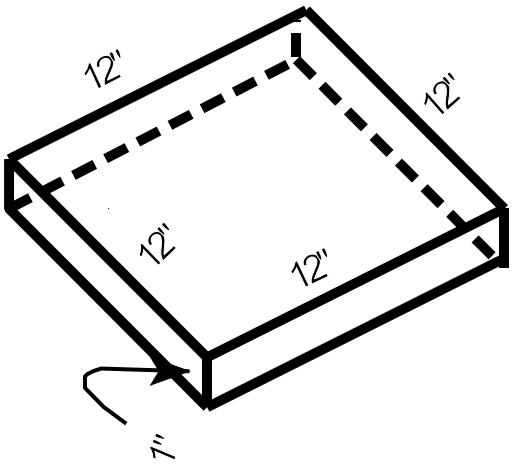
11' X 1.054 = 11.59' X 2 = 23.18'

29. BOARD FEET CALCULATIONS

A BOARD FOOT IS A WAY TO MEASURE THE QUANTITY OF WOOD CONTAINED IN LUMBER. ONE BOARD FOOT MEASURES, 12" WIDE x 12" LONG x 1" THICK.

29.1 BOARD FEET ON DECKS

WHEN CALCULATING THE BOARD FEET REQUIRED FOR DECKING, THE ONLY FACT TO CONSIDER IS THE DECK MATERIAL THICKNESS.



29.2 ___?___ BOARD FEET OF LUMBER ARE REQUIRED FOR A 75 SQUARE FOOT DECK, IF DECK MATERIAL IS 1" x 8" PRESSURE TREATED.

ANSWER: 75

29.3 ___?___ BOARD FEET OF LUMBER ARE REQUIRED FOR A 75 SQUARE FOOT DECK, IF DECK MATERIAL IS 2" x 10" PRESSURE TREATED.

ANSWER: 150

WHEN DETERMINING THE QUANTITY OF PLANKING, THE WIDTH OF THE BOARD DOES NOT MATTER. THE THICKNESS OF THE PLANKING IS THE ONLY FACTOR.

29.4 BOARD FEET IN LUMBER OTHER THAN DECKS

THE FORMULA FOR BOARD FEET IS: **L' X T" X W" / 12 = B.F.**

THE BOARD FEET CONTAINED IN 6 - 1" x 8" x 8' REDWOOD BOARDS IS __?__.

L'	X	T"	X	W"	/	12	=	BOARD FEET
48'	**X**	**1"**	**X**	**8"**	**/**	**12**	**=**	**32**

30. **BID TABULATION**

A CONTRACTOR NEEDS THE FOLLOWING ITEMS FOR AN UPCOMING PROJECT:

PIPE - HARDWARE - PAINT

THE CONTRACTOR OBTAINS THE FOLLOWING QUOTES FROM SUPPLIERS:

SUPPLIER "A" BID ON THE PIPE FOR $350.00
SUPPLIER "B" BID ON THE HARDWARE FOR $215.00
BID ON THE PIPE FOR $345.00
SUPPLIER "B" OFFERS A 5% DISCOUNT IF BOTH ITEMS ARE PURCHASED.
SUPPLIER "C" BID ON THE HARDWARE FOR $212.00
SUPPLIER "D" BID ON THE PAINT FOR $275.00
SUPPLIER "E" BID ON THE PAINT AND HARDWARE FOR $450.00

THE BEST AVAILABLE COST FOR ALL PROJECT SUPPLIES IS _____?_____ DOLLARS.
(SUCCESSFUL BIDS INCLUDE ONE OF EACH ITEM, WITH NO DUPLICATION)

SHOPPING FOR 3 ITEMS ? SET UP 5 COLUMNS, 1 FOR SUPPLIER, 1 FOR $ AMOUNT

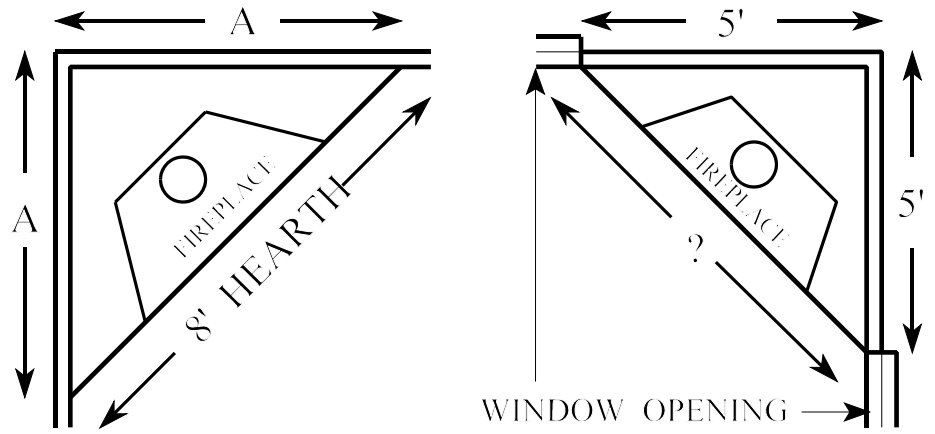
SUPPLIER	PIPE	HARDWARE	PAINT	$ AMOUNT
"A"	✖			350
"B-1"		✖		215
"B-2"	✖			345
"B-3"	✖	✖		[1] 532
"C"		✖		212
"D"			✖	275
"E"		✖	✖	450

[1] $345.00 + $215.00 = $560.00 X .95 = $532.00 (X .95 IS A 5% DISCOUNT)

SUCCESSFUL COMBINATIONS:

	A, B-1, D	=	$840.00
	A, C, D	=	$837.00
	A, E	=	$800.00
	B-1, B-2, D	=	$835.00
	B2, C, D	=	$832.00
LOWEST	**B2, E**	**=**	**$795.00**
	B-3, D	=	$807.00

31. **THE 45 ^{0} CONSTANT IS THE SQUARE ROOT OF 2 *which is* 1.414**



FIREPLACE "A" FIREPLACE "B"

31.1 A CONTRACTOR WANTS TO INSTALL A FIREPLACE AT A 45^{0} ANGLE IN THE CORNER OF A ROOM, THE OWNER SPECIFIED THE HEARTH TO BE 8' WIDE. DISTANCE "A" WOULD BE ____?____ TO ACCOMMODATE THE HEARTH.

SOLUTION: 8' / 1.414 = 5.657' 5' IS WHOLE FEET, CONVERT THE .657

.657 X 12 = 7.884 7"FULL INCHES AND .884 PARTS OF A INCH

.884 X 16 = 14 # OF 16TH 5'- 7 14/16" OR 5'- 7 7/8"

31.2 THE SAME CONTRACTOR IS TO INSTALL A FIREPLACE IN THE CORNER OF ANOTHER ROOM, ONLY THIS ROOM HAS WINDOW OPENINGS LOCATED 5' FROM THE CORNER IN EACH DIRECTION. THE MAXIMUM LENGTH OF THE MANTLE WOULD BE ___?___ , IF YOU ALLOW 1" CLEARANCE ON EACH SIDE.

SOLUTION: 5' X 1.414 = 7.07' 7' IS WHOLE FEET, CONVERT THE .07

.07 X 12 = .84 NO FULL INCHES

.84 X 16 = 13 # OF 16TH 7'- 0 13/16" - 2" = 6'- 10 13/16"

THE CONSTANT 1.414 APPLIES TO 45^{0} ANGLES ONLY.