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Using Trades Math

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Using Trades Math
Introduction

Who should use this workbook?

If it's been awhile since you've been in school or if your math skills feel "rusty", this workbook is for you. As with any skill, math takes practice. If you have ever learned a new sport or musical instrument, you have likely experienced how practice can pay off.

This workbook is designed to refresh your skills by applying math operations to typical construction workplace tasks.

What math skills are required in trades?

Trades people need to be confident and accurate with arithmetic operations such as:

- measuring in both imperial and metric
- using and converting between fractions, decimals and percentages
- using equations and formulae
- using rate, ratio and proportion

In this workbook, you will apply math operations to solve construction problems. These problem situations are likely similar to the ones that you will encounter on the job, and the practice will give you a good idea of which skills you need to improve.

How do I use this workbook?

The five sections of this workbook are independent of each other - you will not need information from one section to solve the problems in another. If you're not confident in your math skills, you can look through the workbook first and start with a section that looks familiar. Once you get "warmed up", you may find that other sections aren't as hard as they appeared at first glance.

As you work through these problems, you may find that there are some skills you need to improve on. There are programs that you can enroll in to give you help with math. There are also resources online and at the library.

How do I download these materials?

Visit www.csc-ca.org.
Pages can be printed back to back.

Table of contents

Measuring

In the trades, it is important to measure accurately. The old saying, "measure twice and cut once," is good advice. If lumber, pipes, sheet metal, carpet, wires, and so on are cut incorrectly, materials are wasted. The replacement materials are an additional cost and so is the labour to do the work over again. From the contractor's point of view, any loss is a loss of profit and limits their ability to continue to offer employment opportunities. Using measuring tapes accurately and using both imperial and metric units confidently are skills worth mastering.

PROBLEMS

1 How many of these fractions of an inch are there in 1 inch?

a) eighths? ______________ b) quarters? ______________

c) halves? ______________ d) sixteenths? ______________

2 Look at the diagram below. What fraction of an inch is represented by each of the marks, a–e? (Diagram scale is not accurate.)

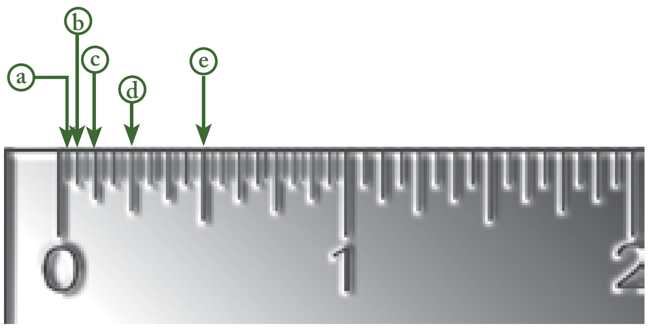
a) $\frac{1}{32}$" ____________

b) ____________

c) ____________

d) ____________

e) ____________



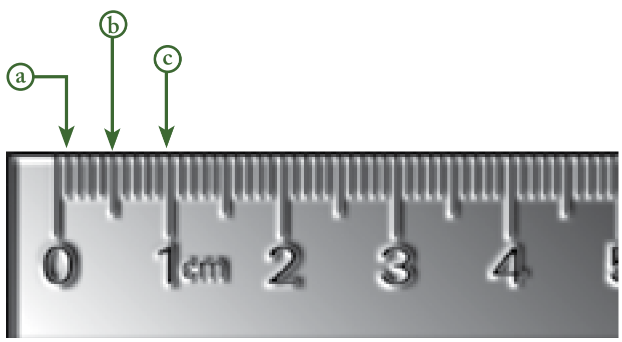
3 How many millimetres are there in 1 centimetre? ____________

4 Look at the diagram below. What distance in metric units is represented by each of the marks a–c? (Diagram scale is not accurate.)

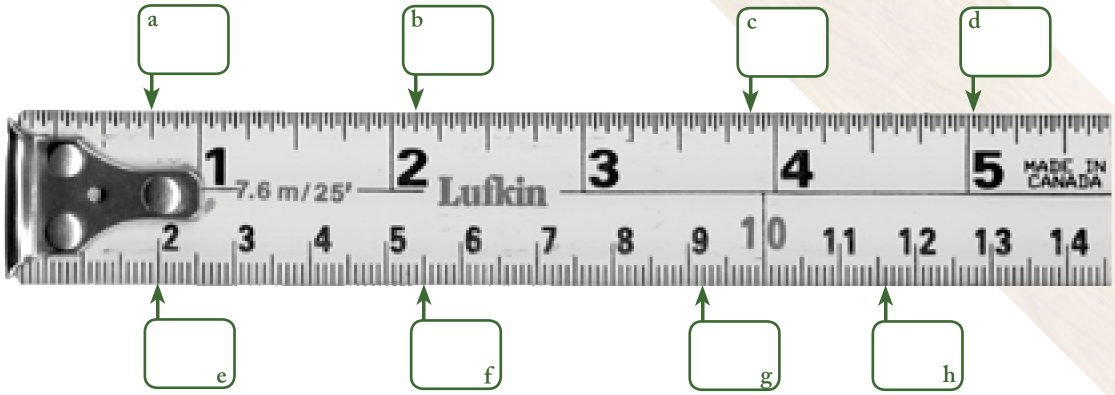
a) ____________

b) ____________

c) ____________

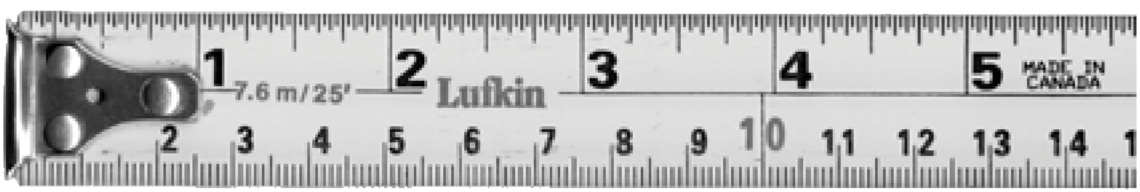


5 Label these measuring tapes with the correct lengths at the marks indicated. Remember to include the correct units: inches or centimetres.



6 Label these measuring tapes at the following points, with an arrow and the letter of the question.

a) 4" b) $1\frac{1}{2}$" c) $5\frac{1}{4}$" d) 10 cm e) 6.5 cm f) 13.3 cm



g) $6\frac{3}{8}$" h) $4\frac{5}{16}$" i) $7\frac{17}{32}$" j) 120 mm k) 188 mm l) 214 mm

7 i) Convert these fractions into sixteenths.

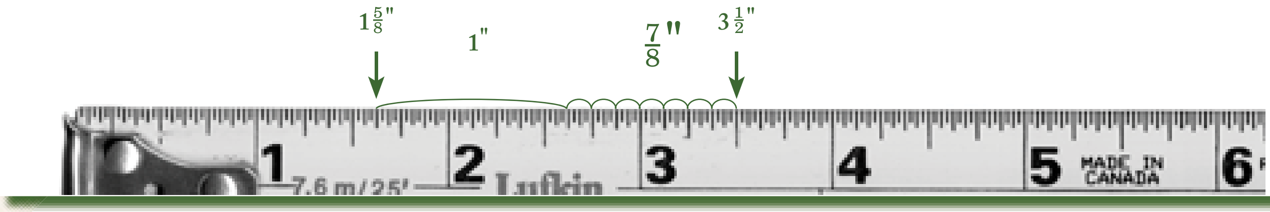
Hint: Use the measuring tapes below. How many sixteenth-marks do you count to get to these fractions of an inch?

a) $\frac{1}{8}$ b) $\frac{3}{4}$ c) $\frac{7}{8}$ d) $\frac{1}{2}$ e) $\frac{3}{8}$

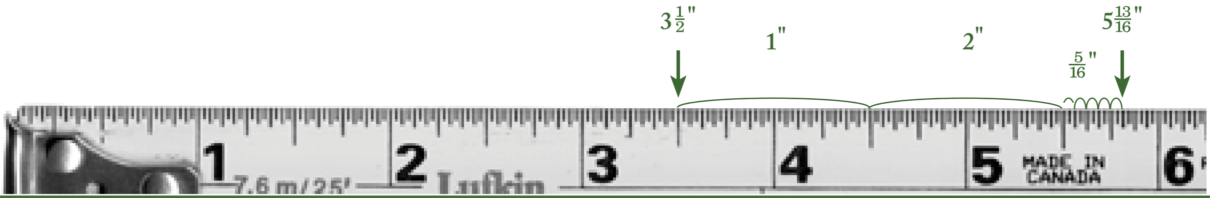
ii) Label the mark for the first number in each question on the measuring tapes. Then, add the two numbers by moving to the right by the second number. Lastly, mark the total on the same measuring tape.

EXAMPLES:

Mark $1\frac{5}{8}$", add $1\frac{7}{8}$".



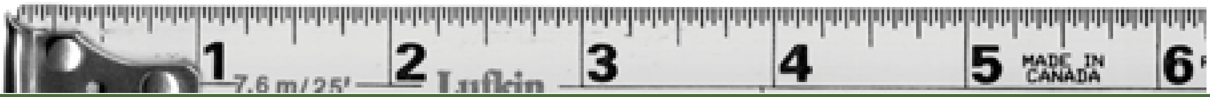
Mark $3\frac{1}{2}$", add $2\frac{5}{16}$".



PROBLEMS

Mark $2\frac{1}{4}$", add $1\frac{1}{4}$".

Mark $1\frac{1}{8}$", add $2\frac{3}{4}$".
Hint: Convert both numbers to the same size mark when adding.



Mark $3\frac{3}{16}$", add $\frac{1}{2}$".

Dimension and Area

Reading a Floor Plan

Many tradespeople read drawings so that they can comply with the architect's and owner's specifications for a building. They scan the diagrams to locate the information they need, and then use that information in calculations.

Look at the Neverbend Residence Floor Plan, on page 8.

1 What section of the house plan is this?

2 How wide is the front of this floor of the house?
Hint: The front is at the bottom of the drawing.

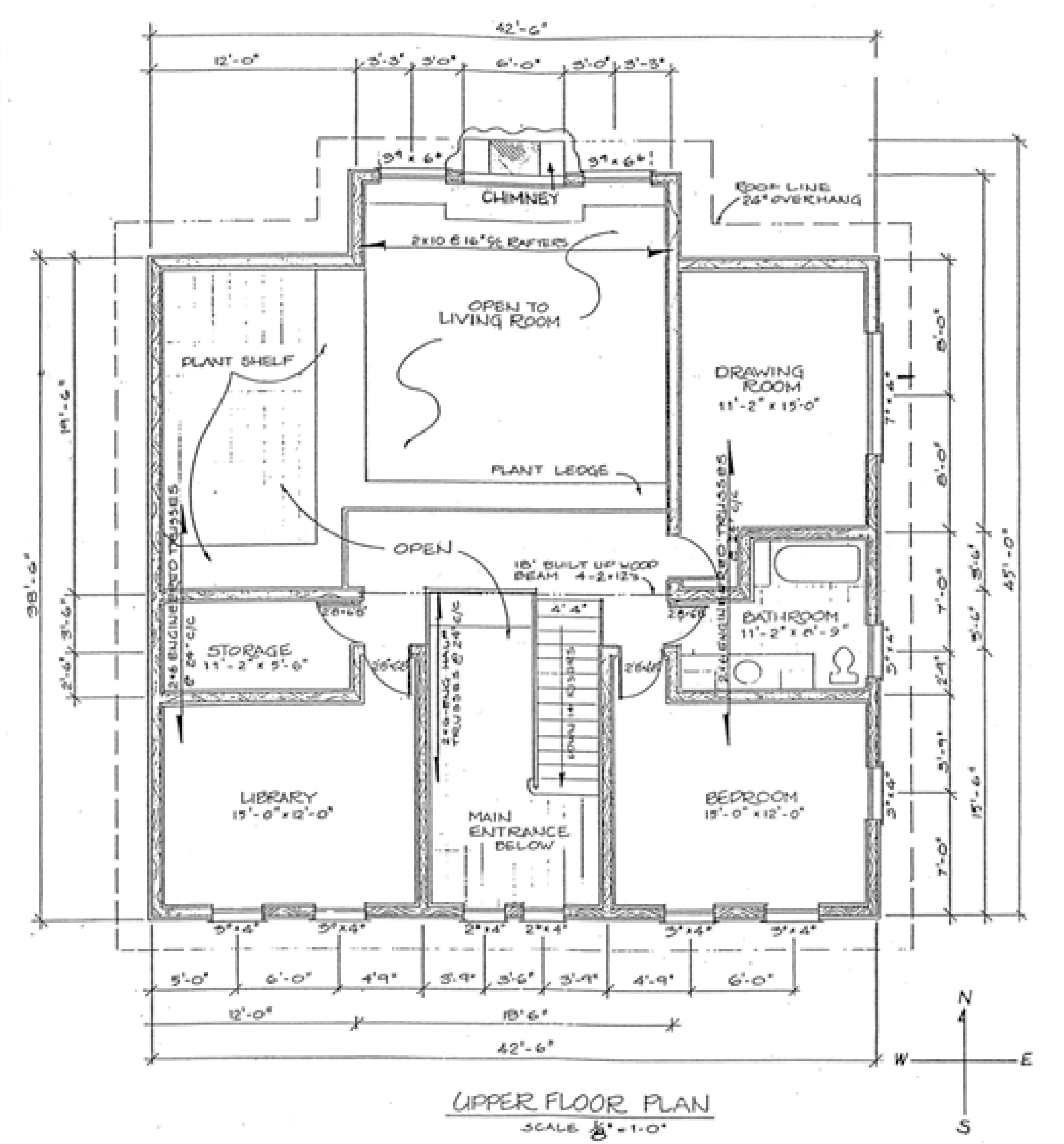
3 Name the room you could enter if you walked up the stairs from the main entrance, then turned right in the hallway, and then went through the door in front of you.

4 What are the length and width (dimensions) of the storage room?

5 What is the height of the doors in this house?

6 The floor plan includes dimensions of rooms and other distances in feet and inches. When using a calculator, it is usually more convenient to work with feet and decimals of a foot. Complete the table below by converting inches to decimals of a foot.

inches	decimals	inches	decimals
1"	$\frac{1}{12}'$ = 1 ÷ 12 = 0.083'	7"	
2"		8"	
3"		9"	
4"		10"	
5"		11"	
6"		12"	1.00' (1 ft)


42'-6"
12'-0"
3'-3"
3'-0"
6'-0"
3'-0"
3'-3"
CHIMNEY
ROOF LINE
24" OVERHANG
2x10 @ 16" o/c RAFTERS
OPEN TO
LIVING ROOM
PLANT SHELF
DRAWING
ROOM
11'-2" x 15'-0"
PLANT LEDGE
OPEN
16' BUILT UP WOOD
BEAM 4-2x12's
STORAGE
11'-2" x 5'-6"
BATHROOM
11'-2" x 6'-9"
LIBRARY
15'-0" x 12'-0"
MAIN
ENTRANCE
BELOW
BEDROOM
15'-0" x 12'-0"
5'-0"
6'-0"
4'9"
3'-9"
3'-6"
3'-9"
4'-9"
6'-0"
12'-0"
18'-6"
42'-6"
38'-6"
19'-6"
45'-0"
15'-6"
N
S
W
E
UPPER FLOOR PLAN
SCALE 1/8" = 1'-0"

7 Convert the following from feet and inches to decimals of a foot.

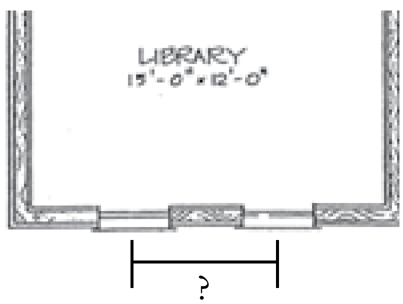
inches	decimals
7' – 2"	7.167'
3' – 9"	
10' – 11"	

distances	decimals
the width of the staircase	4.333'
the width of a door	
the length of the bathroom	

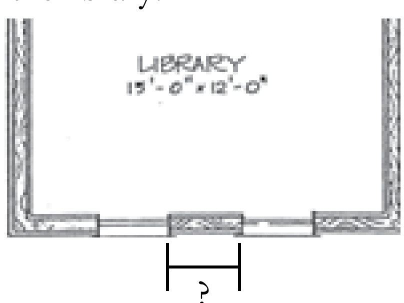
8 There are marks along the bottom of the plan that show the distances between the centres of the windows—the "centre-to-centre distance" between them. The size of each window is also marked next to the window itself, width × height.

a) What is the width of each of the two windows at the front of the library?

b) What is the centre-to-centre distance between these windows?



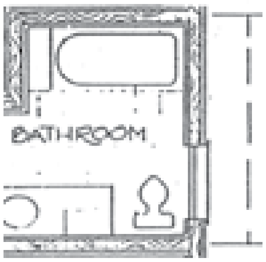
c) What length of siding is needed for the space between the two front windows of the library?



9 a) How long is the chimney in the north wall of the living room?

b) According to the plan, the chimney is as wide as the roof line overhang. Calculate the area of the inside of the chimney.
Hint: Measurements should all be in the same units.

10 a) Look at the lines marking the centres of the north and south bathroom walls on the right side of the plan. Calculate the total distance between these lines.



b) Compare your answer to (a) to the width of the bathroom given on the plan. These answers are different because (a) includes half the width of the bathroom walls. Use this information to calculate the width of the bathroom walls.
Hint: Don't forget that there are two walls!

11 A carpenter needs to order railing for the upper floor hallway. The measurement for the width of the hallway on the floor plan is $\frac{9}{16}$" wide.

a) Locate the scale of the floor plan. What is it?

b) How wide is the actual hallway?
Hint: Convert the scale to $\frac{1}{16}$" = …?

12 The treads of the staircase—the parts you step on—leading up to the second floor of the house will be tiled. The treads are 11" wide.

a) Calculate the area of each tread.

b) Determine how many treads there are in this staircase.
Hint: Don't include the main entrance floor, or the "top" stair, since that's part of the hallway floor.

c) Calculate the total area of the treads of the staircase.

d) If the tile for the stairs costs \$14 per ft^2, how much does the tile for this job cost?

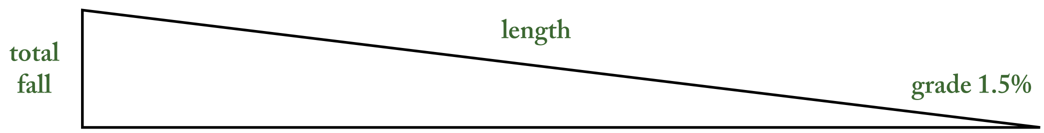
Elevation and Grade

Workers in many trades calculate or use elevations and grade. For example, backhoe and excavator operators remove or place fill according to elevation and grade stakes. Workers in the piping trades install pipes with a slope so that liquids flow by gravity to a pre-determined low point.

When you work with elevations and grades, you are calculating one of three things:

- Total fall
- Grade
- Length or distance

Total fall is the distance that rises or falls from the original elevation. Grade is the slope or change in elevation. Grade can be expressed as a percentage or ratio of the length.
For example, a 4% grade means there is a rise or fall of 4 vertical feet in 100 horizontal feet. A $\frac{1}{4}$"/1' means there is a rise or fall of $\frac{1}{4}$" for every foot of length. Length or distance is the length from the original elevation to the end elevation.



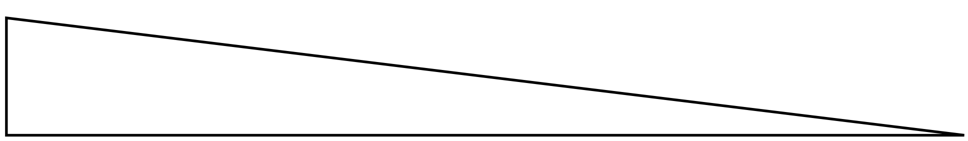
The basic formula used to calculate slope and grade problems is as follows:
Total fall = length × grade

Calculating Total Fall

Total fall can be calculated using percent grade or inches per foot. When total fall is calculated using percent grade, the answer is in feet. When total fall is calculated using inches per foot, the answer is in inches.

EXAMPLE 1: Using Percent Grade

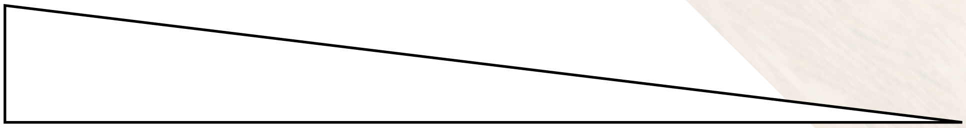
A sewer line slopes at a 2.08 % grade. Calculate the total fall in 30 feet.



Total fall = length × grade	Write the formula.
2.08 % = 0.0208	Convert percent to a decimal.
Total fall = 0.0208 × 30'	Substitute known values into the formula.
	Multiply grade by distance.
Total fall = 0.624'	

EXAMPLE 2: Using Inches Per Foot

A sewer line slopes at $\frac{1}{4}$" per foot grade. Calculate the total fall in 30 feet.

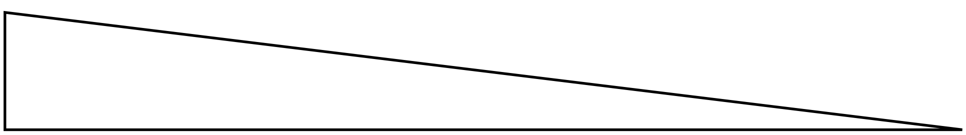


Total fall	=	length × grade	Write the formula.
Total fall	=	$\frac{1}{4}$" × 30'	Substitute known values into the formula. Multiply grade by distance.
Total fall	=	$7\frac{1}{2}$"	The total fall in 30 feet is $7\frac{1}{2}$"

Calculating a Grade

EXAMPLE:

Calculate the grade on a sewer line that is 90 feet in length and has a total fall of $11\frac{1}{4}$" inches. The total fall is given in inches so your answer will be inches per foot.

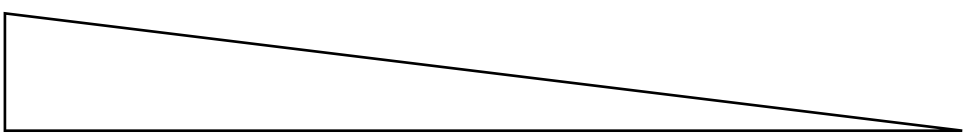


Grade	=	$\frac{\text{total fall}}{\text{length}}$	Write the formula
Grade	=	$\frac{11\frac{1}{4}\text{inches}}{90\text{ feet}}$	Substitute known values into the formula. Divide total fall by length.
Grade	=	$\frac{1}{8}$"	The grade is $\frac{1}{8}$" per foot.

Calculating a Length

EXAMPLE:

Calculate the length of the sewer line. The grade is 1.04% and the total fall is 1.67 feet.



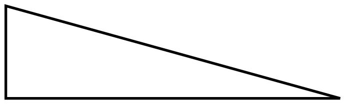
$$\text{Length (feet)} = \frac{\text{total}}{\text{grade}} = \frac{1.67\text{ feet}}{.0104} = 160.6\text{ feet}$$

PROBLEMS

Calculate the total fall, length or grade in the following problems. Round off final answers to two decimal places.

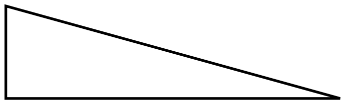
1 Calculate the total fall of the sewer line.
Hint: Your answer will be inches because you are calculating total fall using inches per foot.

Grade = $\frac{1}{4}''$ per foot
Length = 75 feet
Total Fall = ____________________



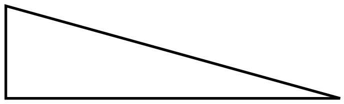
2 Calculate the total fall of the sewer line.
Hint: Your answer will be in feet because you are calculating total fall using percent grade.

Grade = 1%
Length = 125 feet
Total Fall= ____________________



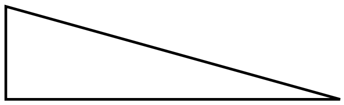
3 Calculate the length of the sewer line.

Total Fall= 0.75 feet
Grade = 1.04 %
Length = ____________________



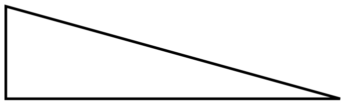
4 Calculate the length of the sewer line.

Total Fall= 11 inches
Grade = $\frac{1}{8}''$ per foot
Length = ____________________



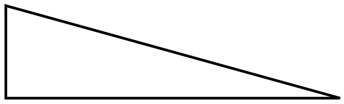
5 Calculate the grade of the sewer line in inches per foot.

Total Fall= 15 inches
Length = 72 feet
Grade = ____________________



6 Calculate the grade of the sewer line as a percentage.

Total fall = 4.5 feet
Length = 375 feet
Grade = ____________________



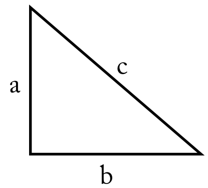
The 3-4-5 Method

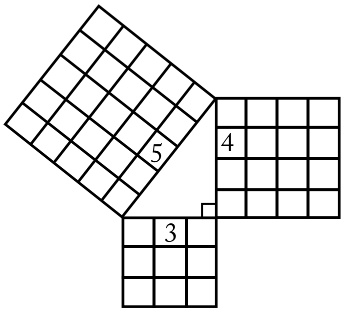
Workers in the construction trades commonly refer to the Pythagorean Theorem as the 3-4-5 Method. The right triangle with sides measuring 3 feet, 4 feet and 5 feet (or 3, 4, and 5 of any other unit) easily demonstrates the idea behind this theorem:

If you multiply the length of each short side by itself, and add the two answers you get, the total is the length of the last side multiplied by itself. $(3 \times 3) + (4 \times 4) = (5 \times 5)$

Although the theorem is often called the 3-4-5 Method, the math works for right triangles of any size or shape. This method is used in the construction industry to lay out the perimeters of buildings, to ensure corners are square, and to calculate the length of rafters and the length of stringers on stairs. Plumbers use this method to calculate lengths of pipes in piping systems. Crane operators and riggers use it to calculate the length of the boom and the length of slings used to lift loads.

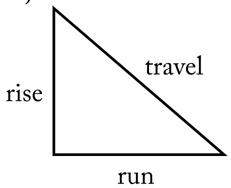
$c^2 = a^2 + b^2$
$a^2 = c^2 - b^2$
$b^2 = c^2 - a^2$





In the construction trades, the sides are often referred to as the travel, the rise and the run.

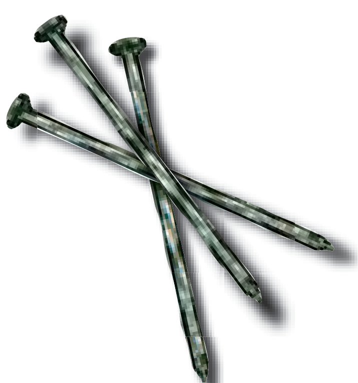
$\text{travel}^2 = \text{rise}^2 + \text{run}^2$
$\text{rise}^2 = \text{travel}^2 - \text{run}^2$
$\text{run}^2 = \text{travel}^2 - \text{rise}^2$

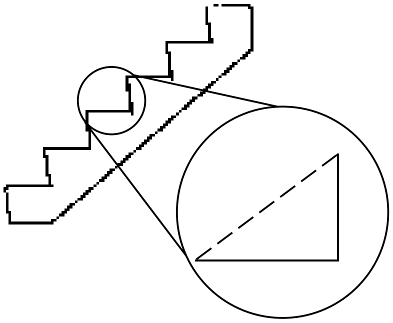


EXAMPLE:

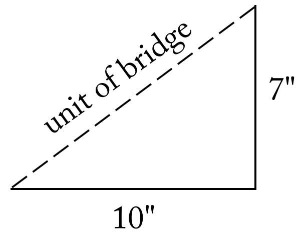
Carpenters calculate, lay out and construct different types of stairs. They use the 3 – 4 – 5 method to calculate the length of the bridge also called the travel or hypotenuse. A stringer is the inclined side of a stair. It supports the treads and risers. Look at the diagram below showing a set of stairs. The bridge has been marked.

Calculate the unit of bridge measurement – the unknown or missing side.





- Label the diagram.
- Write the formula.



In this example, you are asked to calculate the travel.

$travel^2 = rise^2 + run^2$

- Calculate the missing side – the unit of bridge or travel.

$T^2 = 7^2 + 10^2$

$T^2 = 49 + 100$

$T = \sqrt{149}$

$T = 12.2"$

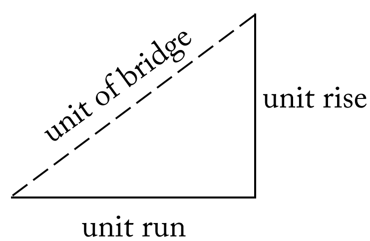
The length of bridge (travel) is 12.2".

Note: The measurements used for the stairs in the example above are considered perfectly proportioned. On the job, this exact set of measurements rarely happens so building codes set the standard for the maximum and minimum lengths for the unit rise (riser) and the unit run (tread).

One building code states:

All stairs within a dwelling unit or serving a single dwelling unit shall have:

	Minimum	Maximum
Unit Rise	4.9375"	7.875"
Unit Run	9"	13.9375"



Use the information in the table to complete problems 2 and 3

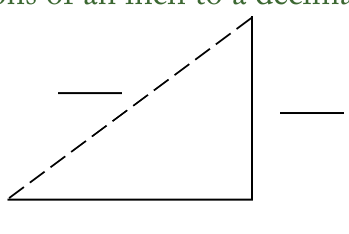
PROBLEMS

1 Calculate the length of the bridge in the diagram below.

Hint: Convert fractions of an inch to a decimal so you can use a calculator.

unit rise = $6\frac{1}{4}"$

unit run = $9\frac{5}{8}"$



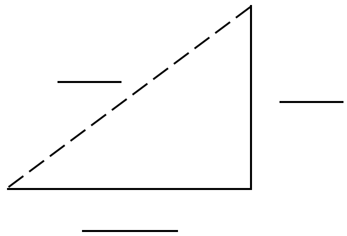
2 a) Calculate the unit rise in the stair below.

Hint: Label the diagram.

b) Does the unit rise meet Building Code standards?

unit of bridge = 13"

unit of run = 9"

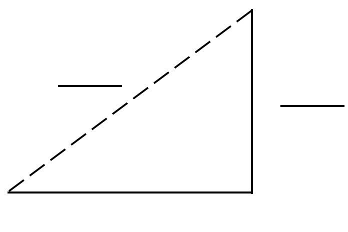


3 a) Calculate the run in the stair below.

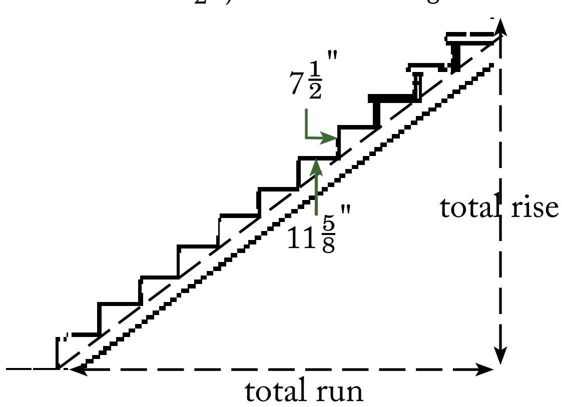
b) Does the unit run meet Building Code standards?

unit of bridge = $12\frac{1}{8}$"

unit of rise = 7"



4 The diagram below shows a flight of stairs. The unit rise and the unit run are shown. There are 11 risers and 11 treads. Unit rise = $7\frac{1}{2}$", unit run = $11\frac{5}{8}$"



a) Calculate the total rise.

b) Calculate the total run.

c) Calculate the length of the stringer.
The stringer is the inclined side of the stair that supports the treads and the risers.

Weight Load Estimation

What happens when a crane lifts a load that makes the crane tip or drops the load? Unfortunately workers could be hurt, the crane, worth millions of dollars, may be damaged, or the load of materials might need to be replaced. These losses are unacceptable. Safety is a prime concern when lifting loads.

Riggers, ironworkers and crane operators are only some of the trades that calculate the approximate weight of loads and determine the safest way to secure the load. Other trades workers calculate the weight of loads to be lifted by forklift trucks, mobile cranes and other lifting devices.

Calculating weight per square foot

The weight for steel beams, slabs and angle iron are usually calculated in pounds per square foot.

1 Complete the table below. Fill in the missing weight load estimations for steel plate per square foot.

2 Can you spot the pattern in estimating the weight of steel plate per square foot?

Weight of Steel Plate per Square Foot

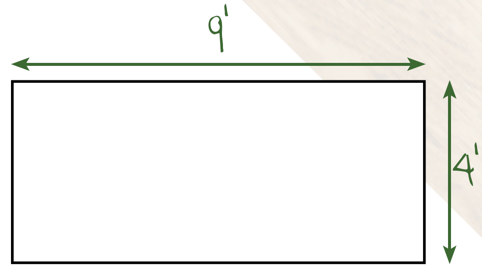
$\frac{1}{8}$"	5 lbs
$\frac{1}{4}$"	10 lbs
$\frac{3}{8}$"	
$\frac{1}{2}$"	
$\frac{5}{8}$"	
$\frac{3}{4}$"	
$\frac{7}{8}$"	35 lbs
1"	40 lbs

What is the pattern? ______________________________

EXAMPLE:

Calculate the weight of a sheet of steel plate $\frac{1}{8}$" thick measuring 4' × 9'.

- Draw a diagram and label it with the measurements.

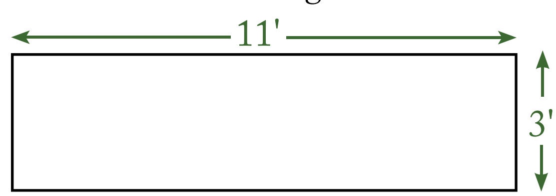


- Calculate the area of the sheet of steel plate.
- A = L × W
  A = 4' × 9'
  A = 36 ft^2
- Locate the weight for $\frac{1}{8}$" steel plate.
  The weight of $\frac{1}{8}$" steel plate is______ per square foot.
- Multiply the area of the steel plate by the weight per square foot to get the weight in pounds.
  Weight = 36 ft^2 × 5 = 180 lbs
  The steel plate weighs approximately 180 lbs.

PROBLEMS

Calculate the weight of the steel plate in each of the questions below. Use the example to help you decide how to do the calculations.

3 Calculate the weight of a sheet of steel plate $\frac{5}{8}$" thick measuring 3' × 11'.

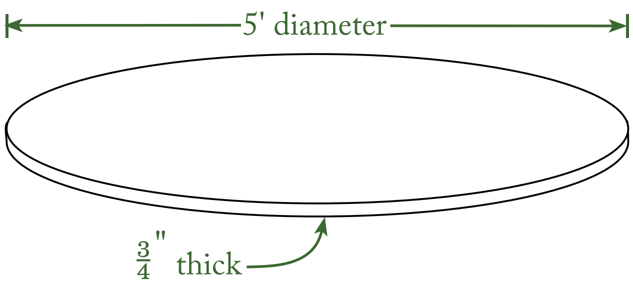


4 Calculate the weight of a sheet of steel plate $\frac{3}{8}$" thick measuring 6' × 12'.

5 Calculate the weight of a sheet of steel plate $\frac{7}{8}$" thick measuring 5.5' × 8.75'.

6 Calculate the weight of a sheet of steel plate $\frac{1}{2}$" thick measuring 2'6" × 7'9".

7 Calculate the weight of a steel plate $\frac{3}{4}$" thick with a diameter of 5'.
You will need to use the formula for area of a circle. $A = d^2 \times .7854$ or πr^2



8 Calculate the weight of a steel plate 3" thick with a diameter of 7'.

Calculating weight per length – Rebar

Steel rods known as rebar are used to reinforce concrete. Rebar is identified by diameter and by length. A code for the diameter is embossed on the side, which helps ironworkers to calculate density, and the lengths are marked on the rebar with painted stripes.

Colour code for length

colour	digit	colour	digit
white	1	light green	6
red	2	orange	7
dark green	3	light blue	8
yellow	4	black/brown	9
dark blue	5	pink	0

Each colour of stripe represents a digit, and the complete number represents the length of the rebar in millimetres. The number is read with the stripe nearest the end of the rod coming first; the rest of the stripes are read in order towards the centre of the rod.

9 The weight of the rebar is found by multiplying the density of the rebar — how heavy it is per metre—by the length of the bar in metres. This density table is used as a guide to calculating the density of rebar. Complete the table below.

diameter	factor	density
10M	.785 × **1**	.785 kg/m
15M	.785 × **2**	1.57 kg/m
20M	.785 × **3**	2.355 kg/m
25M	.785 × **5**	3.925 kg/m
30M	.785 × **7**	
35M	.785 × **10**	
45M	.785 × **15**	
55M	.785 × **25**	

Ironworkers are expected to memorize the numbers in bold and calculate density. The numbers in “10M”, “15M”, etc., are not used in calculations.

EXAMPLE:

Calculate the weight of a 25M piece of rebar that is 11.50 m long.

The piece is 25M, so it weighs 3.925 kg/m.
Since it is 11.5 m long, the weight is 3.925 × 11.5 = 45.1375 kg.

10 Use the example to help you decide how to do the calculations.

a) Find the weight of a 20M piece of rebar that is 9.00 m long.

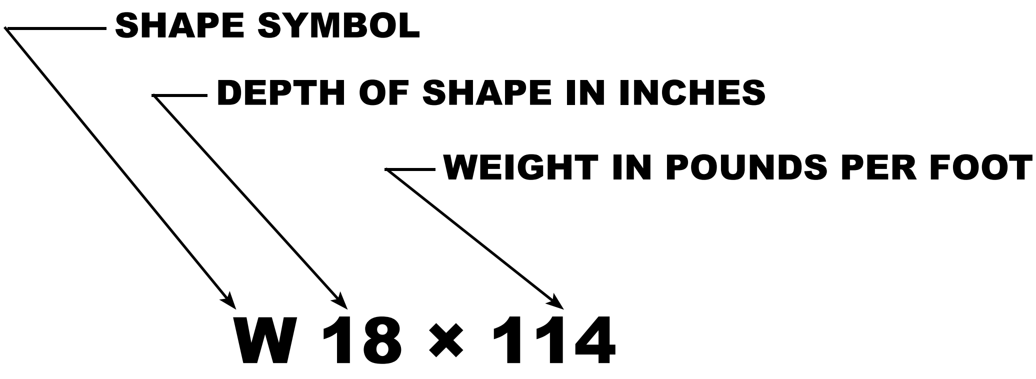
b) Find the weight of the piece of rebar shown here:

c) How heavy is a bundle of rebar made up of 75 pieces of 35M rebar, if each rod is 6500 mm in length?

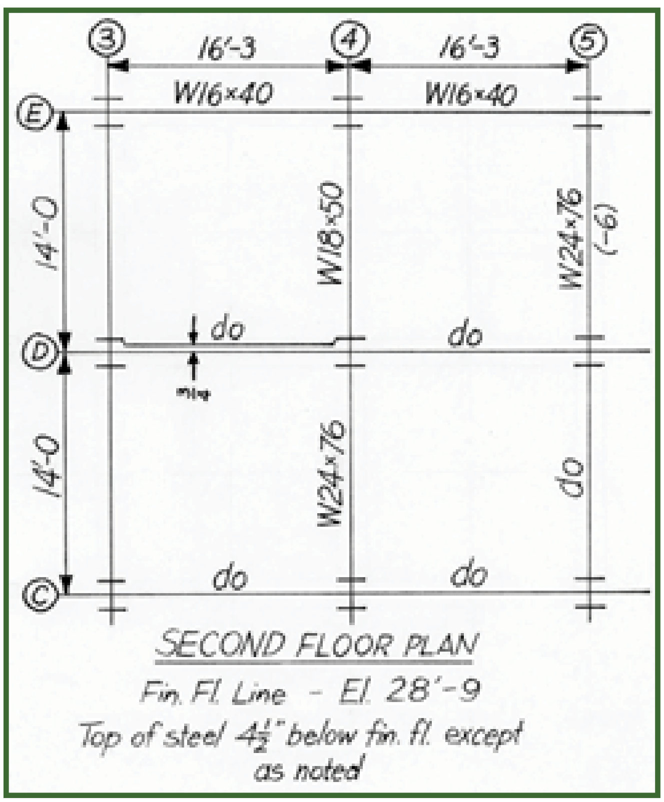
Calculating weight per length – I-Beams

Crane operators need to know the weights of materials so that the crane can safely lift the load. Look at the *A. Inch Designation* and the *B. Second Floor Plan.* A crane lifts the ten I-beams labelled in the Plan to the second floor. The operator needs to estimate the total weight of the load. The lengths of all of the I-beams are provided on the Plan.

A. Inch Designation



B. Second Floor Plan



Here are a few notes to help you read the Plan:
The numbers $\frac{3}{4}$ and (–6) are not needed for this calculation.
The abbreviation "do" means ditto or this I-beam is the same as the one above it, or to the left of it, in the Plan. (For example, two of the three beams shown in the space between ④ and ⑤ are marked "do", which means all three beams are the same type: W16 × 40)

11 a) How many of the I-beams are 16' - 3" long?
Hint: Remember that 16' - 3" means “sixteen feet and three inches”.

b) Circle the number that tells how many pounds one foot of this type of I-beam weighs.

W24 × 76

c) How much do the 16' - 3" I-beams weigh per foot?

d) Calculate the weight of all the 16' - 3" I-beams.
Hint: Convert 3" to a decimal of a foot.

e) How long are the remaining I-beams?

f) I-beams come in different shapes or designations such as W16 × 40.
List the other designations of I-beams in the diagram, besides W16 × 40.
How many of each designation are there?

g) Calculate the total weight of all ten I-beams.

Answer Key - Measuring

1 a) 8 eighths b) 4 quarters c) 2 halves d) 16 sixteenths

2 a) $\frac{1}{32}''$ b) $\frac{1}{16}''$ c) $\frac{1}{8}''$ d) $\frac{1}{4}''$

e) $\frac{1}{2}''$

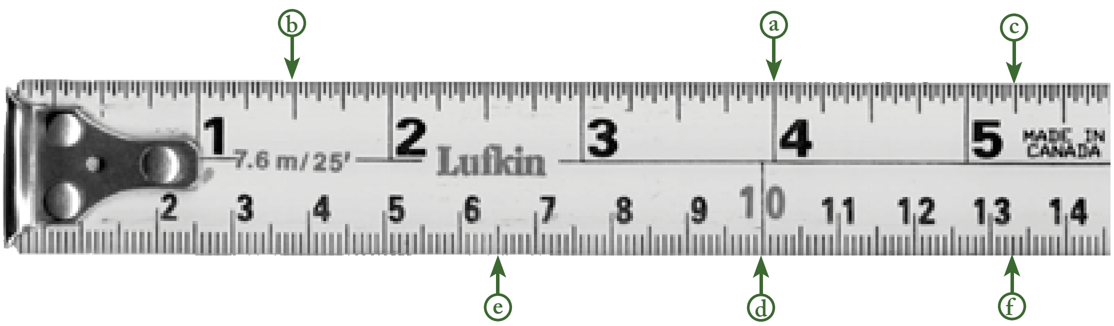
3 10 millimetres

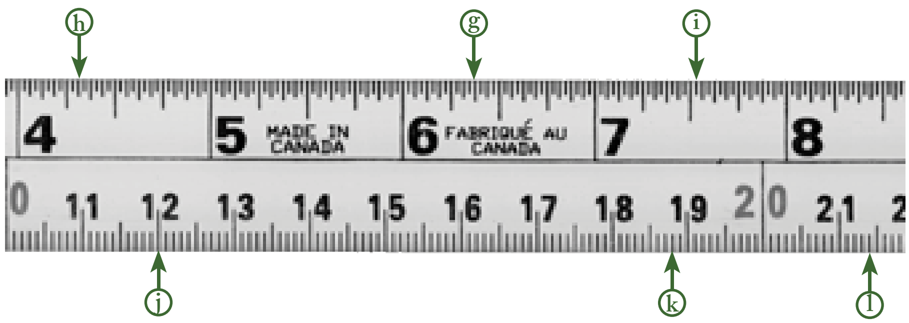
4 a) 1 mm b) 5 mm c) 10 mm or 1 cm

5 a) $\frac{3}{4}''$ b) $2\ \frac{1}{8}''$ c) $3\ \frac{7}{8}''$ d) $5\ \frac{1}{32}''$

e) 2 cm/20mm f) 5.5 cm/55mm g) 9.2 cm/92 mm h) 11.6 cm/116 mm

6





7 i) a) $\frac{2}{16}''$ b) $\frac{12}{16}''$ c) $\frac{14}{16}''$ d) $\frac{8}{16}''$ e) $\frac{6}{16}''$

ii) a) $3\ \frac{1}{2}''$ b) $3\frac{7}{8}''$ c) $3\frac{11}{16}''$

Answer Key – Dimension and Area

1 Upper floor

2 42'-6"

3 The drawing room.

4 11'-2" × 5'-6"

5 6'-8"

6

inches	decimals	inches	decimals
1"	0.083'	7"	0.58 (0.583')
2"	0.17' (0.167')	8"	0.67' (0.667')
3"	0.25'	9"	0.75'
4"	0.33' (0.333')	10"	0.83' (0.833')
5"	0.42' (0.417')	11"	0.92' (0.917')
6"	0.5'	12"	1'

7

inches	decimals
7' – 2"	7.167'
3' – 9"	3.75'
10' – 11"	10.917'

distances	decimals
the width of the staircase	4.333'
the width of a door	2.667'
the length of the bathroom	11.167'

8 a) The floor plan says the windows are 3' - 0" × 4' - 0", so the windows are 3 feet wide.

b) According to the plan, the centre-to-centre distance is 6 feet.

c) The distance between the windows is the centre-to-centre distance minus half a window on either side. Half the width of the windows is 1.5', so the width is
6' - 2 × (1.5') = 3'
So, three feet of siding is needed for the space between the windows.

9 a) 6 feet

b) The roof line overhang is marked as being 24" wide. 24" ÷ 12 = 2 feet
The area of the chimney is its length times it width. 6' × 2' = 12 ft^2
The area of the inside of the chimney is 12 ft^2.

10 a) The distance shown is 7'-0" + 2'-9" = 9'-9".

b) The plan tells us that the width of the bathroom is 8'-9". Our calculation in (a) is the width of the room, plus half the thickness of the north wall, plus half the thickness of the south wall.
The difference between the two measurements is 9'-9" – 8'-9" = 1'-0".
This is half of the thickness of two walls. That's the same thing as the whole thickness of one wall, so each wall is 1 foot wide.

11 a) The scale is at the bottom of the floor plan: $\frac{1}{8}$"= 1'-0".

b) $\frac{1}{8}$" on the plan represents 1' of distance in the real house. If we divide both numbers by 2, we get $\frac{1}{16}$" = $\frac{1}{2}$', or 6".
The hallway on the floor plan is $\frac{9}{16}$". Set up a ratio:
$\frac{1}{16}$" : 6" = $\frac{9}{16}$" : ?
6 × $\frac{9}{16}$ = ? × $\frac{1}{16}$"
$\frac{54}{16}$: $\frac{1}{16}$ = 54
So the hallway is 54 inches, or 4'-6".

12 a) We can either work in inches or fractions of a foot.
Since fractions of a foot will be more useful later on, this is the solution we'll use. (A solution in square inches isn't wrong, however.)
We are told that the treads are 11" wide, or 0.917'.
The plan says that the stairs are 4'-4" wide. That's $4\frac{4}{12}$' or 4.333'.
The area is 4.333' × 0.917' = 3.972 ft^2 (or 572 in^2).

b) There are 13 treads in the staircase.

c) We know the area of each tread is 3.972 ft^2, so 13 of them makes a total area of 13 × 3.972 = 51.639 ft^2 (or 7 436 in^2).

d) The total area for the job is 51.639 ft^2. (If you did all your calculations in square inches, you would divide your answer by 144 to convert to ft^2.)
The cost is \$14 × 51.639 ft^2 = \$722.94

Answer Key – Elevation and Grade

1 Total Fall = Length × Grade = 75 feet × $\frac{1}{4}$ inch = $18\frac{3}{4}$ inches

2 Total Fall = Length × Grade = 125 feet × 0.01 = 1.25 feet

3 Length = $\dfrac{\text{Total Fall}}{\text{Grade}} = \dfrac{.075 \text{ feet}}{0.0104}$ = 72.12 feet

4 Length = $\dfrac{\text{Total Fall}}{\text{Grade}} = \dfrac{11 \text{ inches}}{\frac{1}{8} \text{ inch per foot}}$ = 88 feet

5 Grade = $\dfrac{\text{Total Fall}}{\text{Length}} = \dfrac{15 \text{ inches}}{72 \text{ feet}}$ = 0.208 inches per foot = $\frac{3}{16}$ inches per foot

6 Grade = $\dfrac{\text{Total Fall}}{\text{Length}} = \dfrac{4.5 \text{ feet}}{375 \text{ feet}}$ = 0.012 = 1.2%

Answer Key – The 3-4-5 Method

1 Convert fractions of an inch to decimals.

$6\frac{1}{4}" = 6.25"$

$9\frac{5}{8}" = 9.625"$

Calculate the length of the bridge.

$a^2 + b^2 = c^2$

$6.25^2 + 9.625^2 = c^2$

$39.0625 + 92.640625 = c^2$

$131.70312 = c^2$

$\sqrt{131.70312} = c$

$11.48 = c$

The length of bridge is 11.48"

2a Calculate the unit rise.

$c^2 - b^2 = a^2$

$13^2 - 9^2 = a^2$

$169 - 81 = a^2$

$88 = a^2$

$\sqrt{88} = a$

$9.38 = a$

b The unit rise is 9.38" and does not meet the Building Code standard. (9.38" is outside the standard 4.9375" up to 7.875")

3 a Convert fractions to decimals.

$12\frac{1}{8}" = 12.125"$

Calculate the unit run.

$c^2 - a^2 = b^2$

$12.125^2 - 7^2 = b^2$

$147.01562 - 49 = b^2$

$98.01562 = b^2$

$\sqrt{98.01562} = b$

$11.83 = b$

$9.90 = b$

b The unit run is 9.90" and meets the Building Code standards. (9.90" is within the standard 9" up to 13.9375")

4 Convert fractions to decimals.

$7\frac{1}{2}" = 7.5"$

$11\frac{5}{8}" = 11.625"$

a) Calculate the total rise.

$11 \times 7.5 = 82.5"$

b) Calculate the total run.

$11 \times 11.625 = 127.875"$

c) Calculate the length of the stringer.

$a^2 + b^2 = c^2$

$82.5^2 + 127.875^2 = c^2$

$6806.25 + 16352.01563 = c^2$

$23158.26563 = c^2$

$\sqrt{23158.26563} = c$

$152.1784 = c$

The length of the stringer is 152.1784"
(Converted to feet 152.1784" = 12' $8\frac{3}{16}"$)

Answer Key – Weight load estimation

1

Weight of Steel Plate per Square Foot

$\frac{1}{8}$"	5 lbs
$\frac{1}{4}$"	10 lbs
$\frac{3}{8}$"	15 lbs
$\frac{1}{2}$"	20 lbs
$\frac{5}{8}$"	25 lbs
$\frac{3}{4}$"	30 lbs
$\frac{7}{8}$"	35 lbs
1"	40 lbs

2 Every $\frac{1}{8}$" adds 5 more pounds.

3 Calculate the area.

3' × 11' = 33 ft²

Calculate the weight.

$\frac{5}{8}$" thick steel plate = 25 lbs/ft²

33 ft² × 25 = 825 lbs

4 Calculate the area.

6' × 12' = 72 ft²

Calculate the weight.

$\frac{3}{8}$" thick steel plate = 15 lbs/ft²

72 ft² × 15 = 1 080 lbs

5 Calculate the area.

5.5' × 8.75' = 48.125 ft²

Calculate the weight.

$\frac{7}{8}$" thick steel plate = 35 lbs/ft²

48.125 ft² × 35 = 1 684.375 or 1 684 lbs

6 Convert fractions to decimals.

2'6" = 2($\frac{6}{12}$) = 2$\frac{1}{2}$ = 2.5'

7'9" = 7(9 over 12) = 7$\frac{3}{4}$ = 7.75'

Calculate the area.

2.5' × 7.75' = 19.375 ft²

Calculate the weight.

$\frac{1}{2}$" thick steel plate = 20 lbs/ft²

19.375 ft² × 20 = 387.5 or 388 lbs

7 Calculate the area.

d² × .7854 = 5² × .7854 = 19.635 ft²

Calculate the weight.

$\frac{3}{4}$" thick steel plate = 30 lbs/ft²

19.635 ft² × 30 = 589.05 or 589 lbs

8 Calculate the area.

d² × .7854 = 7² × .7854 = 38.4846 ft²

Calculate the weight.

1"	40 lbs

3" thick steel plate = 40 × 3 = 120 lbs/ft²

38.4846 ft² × 120 = 4 618.152 or 4 618 lbs

Calculating weight per length – Rebar

1 **30M:** 5.495 kg/m; **35M:** 7.85 kg/m; **45M:** 11.775 kg/m; **55M:** 19.625 kg/m

2 a) According to the table, 20M rebar weighs 2.355 kg per metre.
It is 9 m long, so the weight is 9 × 2.355 = 21.195 kg.

b) This is a piece of 30M rebar, so it weighs 5.495 kg per metre.
The stripes say it is 7500 mm, or 7.5 m. 5.495 kg/m × 7.5 m = 41.2125 kg

c) The table tells us that 35M rebar is 7.85 kg per metre. 6500 mm is the same as 6.5 m. The weight of each rod is 7.85 kg/m × 6.5 m = 51.025 kg. 75 rods weight 75 times as much, so the total weight is 51.025 × 75 = 3826.875 kg

Calculating weight per length – I-Beam

3 a) There are six I-beams that are 16'-3" long.

b) W24 × 76

c) According to the Inch Designation, the number after the "×" tells us the weight per foot, so all these I-beams weigh 40 lbs/ft.

d) 16'-3" is the same as $16\frac{3}{12}$' or 16.25'. Each one weighs 40 lbs/ft, so the weight of each I-beam is 16.25 × 40 = 650 lbs.
Because there are six of them, the total weight is 650 × 6 = 3900 lbs.

e) All of the remaining I-beams are 14'-0".

f) There is one I-beam that is designated W18 × 50, and three that are W24 × 76.

g) The one I-beam that is W18 × 50 is 50 lbs/ft × 14' = 700 lbs.
The other three I-beams each weigh 76 lbs/ft.
Each of these I-beams weighs 76 lbs/ft × 14' = 1064 lbs.
There are three of these, so their total weight is 1064 lbs × 3 = 3192 lbs.
If we add up these weights, we get 3900 lbs + 700 lbs + 3192 lbs = 7792 lbs.
The total weight for all ten I-beams is 7792 lbs.

The Construction Sector Council is a national organization committed to the development of a highly skilled workforce – one that will support the future needs of the construction industry in Canada. Created in April 2001, and financed by both government and industry, the CSC is a partnership between labour and business.

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Funded by the Government of Canada's Sector Council Program

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Developed by the BC Construction Industry Skills Improvement Council