EVALUATING
ACADEMIC READINESS
FOR APPRENTICESHIP TRAINING
Revised for
ACCESS TO APPRENTICESHIP

MATHEMATICS SKILLS
POWERS AND ROOTS

AN ACADEMIC SKILLS MANUAL
for
The Metal Work Trades

This trade group includes the following trades:
Heat & Frost Insulator, Iron Worker,
Precision Metal Fabricator, Sheet Metal Worker, and
Welder & Fitter

Workplace Support Services Branch
Ontario Ministry of Training, Colleges and Universities

Revised 2011

In preparing these Academic Skills Manuals we have used passages, diagrams and questions similar to those an apprentice might find in a text, guide or trade manual.

This trade related material is not intended to instruct you in your trade. It is used only to demonstrate how understanding an academic skill will help you find and use the information you need.

MATHEMATICS SKILLS:
POWERS AND ROOTS

An academic skill required for the study of the Metal Work Trades

This skills manual looks at two mathematical skills: working with powers of ten and calculating squares and square roots.

Using numbers written as powers of ten can make it easier to work with numbers that have many zeros. Squaring a number and calculating square roots are useful if you need to determine a length using Pythagoras' Theorem.

This skills manual, covers the following topics:

Part I: Powers of Ten

- ♦ place value
- ♦ exponents
- ♦ powers of ten, including
  - writing numbers as powers of ten
- ♦ decimal numbers as powers of ten, including
  - writing decimal numbers as powers of ten
- ♦ multiplying and dividing powers of ten, including
  - working with integers

Part II: Squares and Square Roots

- ♦ squaring a number, including
  - squares of numbers one to twelve
  - finding the square of a larger number
  - squaring a decimal or a fraction
  - squaring units
- ♦ area
- ♦ finding square roots, including
  - using a calculator
  - square roots of numbers with units

PART I: POWERS of TEN

Before we begin working with powers of ten, we need to know about some important parts of our number system and how they can be used.

We can write any number we want to with only ten symbols, or ***digits***. The digits are:

0, 1, 2, 3, 4, 5, 6, 7, 8, and 9.

We can write any amount we choose, from the largest to the smallest using only these nine digits. Here's how.

Our number system is based on the idea of ***place values***. We use the number symbols or ***digits*** from 0 to 9 to write numbers. *The place or position of a digit in the number indicates its place value*.
Let's look at the number 785.

- The digit on the far right hand side is in the ones place. 785 has 5 ones.
- The digit to the left of the ones place is in the tens place. 785 has 8 tens.
- And the next digit to the left is in the hundreds place. 785 has 7 hundreds.
- (See Table 1 for place values up to a million.)

Whole numbers: When we write a number such as six thousand, four hundred and eighty-two using digits instead of words, we don't show the thousands, the hundreds, the tens and the ones separately.

Instead, we put:
the 2 in the ones place,
the 8 in the tens place,
the 4 in the hundreds place, and
the 6 in the thousands place.

The written number looks like this: 6 482.

We are so familiar with this system that we know automatically that in a number like 57 213, the digit 2 (three places from the right) stands for two hundred.

The number 4 782 951 has seven digits. Table 1 shows the place value of each digit:

Table 1: Place Values from Ones to Millions

millions	hundred thousands	ten thousands	thousands	hundreds	tens	ones
4	7	8	2	9	5	1

We read this number as four million, seven hundred eighty-two thousand, nine hundred fifty-one.

When we refer to a specific digit in a larger number, we use the place value column to find the value the digit represents.

Example: In the number 356, the digit 5, two places from the right side, represents fifty. We know the 5 represents fifty because it is in the tens column.

Decimal numbers: Place values are also used to write decimal numbers. A ***decimal number*** indicates a partial amount that is less than one. A period called a ***decimal point*** is written after the ones place to signify the decimal portion of the number.

- The first place after the decimal point (to the right) is called the tenths place.
  - *The digit in the tenths place is the same as the numerator of a fraction with the denominator 10.*

Example: The decimal .7 is the same as the fraction 7/10.

- The next place to the right is called the hundredths place.
  - The digit 3 in the decimal number .538 is in the hundredths place.
- The place value to the right of the hundredths place is called the thousandths place.
  - The 8 in the decimal number above is in the thousandths place.

Refer to Table 2 below which shows place values after the decimal (and also the digit 4 in the ones place value). Notice that *th* is used to indicate decimal place values.

Table 2: Place Values after the Decimal

ones	**decimal**	tenths	hundredths	thousandths	ten thousandths	hundred thousandths	millionths
4	.	6	2	8	3	7	5

In a number such as 4.628375, the digit 2, in the hundredths column represents 2/100. The digit 3, in the ten thousandths column represents 3/10 000 and so on.

Putting all the place value fractions together gives the fraction:

$$\frac{628\ 375}{1\ 000\ 000}$$

This is the same as the decimal .628375.

EXPONENTS

We can organize numbers in many different ways. For example, when we have to multiply any number by itself many times, we use ***exponents*** to indicate this kind of multiplication.

A short form of indicating that 5 is to be multiplied by itself (5 x 5) is writing 5^2.

- This is read "*five squared*" or "*five times five*" or "*five to the second power*".
- The whole number, in this case five, is called the ***base*** or the factor.
- The small number 2 written after the base and slightly above it is called the ***exponent***.

The exponent tells how many times to multiply the base by itself. A number with an exponent like 2^4 tells us that the base 2 is to be multiplied by itself four times, like this: 2 x 2 x 2 x 2

The base 8 with the exponent 3, written 8^3, tells us that eight is to be multiplied by itself three times, like this: $8^3 = 8 \times 8 \times 8$

The exponent ^{0} is unusual. Any number with the exponent ^{0} is equal to 1.

$8^0 = 1$
$2^0 = 1$
$10^0 = 1$

POWERS OF TEN

Numbers such as 100, 1000, 10 000, and 100 000 can all be calculated by multiplying 10 times itself.

100 = 10 x 10
1 000 = 10 x 10 x 10
10 000 = 10 x 10 x 10 x 10 and so on.

These numbers can be written in an exponential form. Ten is the base, written with the required exponent, such as 10^2, 10^3, or 10^4 and so on. *Numbers with exponents that use ten as the base are called* ***powers of ten****.*

The term "power of ten" *can refer to these kinds of numbers whether they are written with an exponent (10^3) or with the multiplication indicated (10 x 10 x 10) or in long form (1000). Any of these forms can be referred to as a power of ten. However, for this skills manual, "power of ten" will refer to the exponential form, 10^2, 10^4, 10^6, and so on.*

We interpret powers of ten as follows:

$10^0 = 1$

10^1 = ten to the first power, which is 10
$10^1 = 10$

10^2 = 10 x 10, it is read as ten squared
$10^2 = 100$

10^3 = 10 x 10 x 10, it is read as ten to the third
10^3 = 1 000

10^4 = 10 x 10 x 10 x 10, it is read as ten to the fourth
10^4 = 10 000

10^{10} = 10 x 10 x 10 x 10 x 10 x 10 x 10 x 10 x 10 x 10, it is read ten to the tenth
10^{10} = 10 000 000 000

Look at the examples again. Notice that in each case the number of zeros after the one in the answer is the same as the exponent. So 10^7 will be a one with seven zeros after it (10 000 000).

Writing Powers of Ten

To write a power of ten in the exponential form:

1. Count the number of zeros after the first digit, 1.
2. The number used as an exponent after the base 10 is the same as the number of zeros.

Example: Write 100 000 as a power of ten with an exponent.

There are 5 zeros after the digit 1. The exponent will be the same number as the number of zeros. Write the number 10 as the base with the exponent 5.

100 000 written as a power of ten is 10^5.

Example: Write 10 000 000 as a power of ten.

There are seven zeros after the first digit, 1. Write the number 10 as the base with the exponent 7.

10 000 000 as a power of ten = 10^7.

Example: Write 100 as a power of ten.

There are two zeros after the first digit, 1.

100 as a power of ten = 10^2

Writing a power of ten in the long form

To reverse the process and write a power of ten in the long form:

1. Write a 1.
2. Then write as many zeros after the 1 as the number that forms the exponent.
3. *Do not add the zeros to the base 10. Add the zeros to the digit 1.*

Example: Write 10^4 in long form.

The exponent is 4 so there will be four zeros.
Write a 1 with four zeros after it.

10^4 written in long form (or multiplied out) is 10 000.

Example: Write 10^6 in the long form.

The exponent is six. Write 1 with six zeros after it.

10^6 = 1 000 000

DECIMAL NUMBERS AS POWERS OF TEN

So far we have looked at how to write whole numbers as powers of ten. Decimal numbers like .0001 can also be written as powers of ten. The method of writing decimal powers of 10 with an exponent is a little different from writing whole numbers. First let's look at some decimal powers of ten:

10^{-1}	is read	ten to the negative one	=	.1
10^{-2}	is read	ten to the negative two	=	.01
10^{-3}	is read	ten to the negative three	=	.001
10^{-4}	is read	ten to the negative four	=	.0001
10^{-5}	is read	ten to the negative five	=	.00001

When you look at these examples carefully, you notice that, in each one, *the number of decimal places in the answer is the same as the digit forming the exponent*. So 10^{-7} will have 7 decimal places.

Writing Decimal Powers of Ten

To write a decimal number consisting of zeros followed by the digit 1 as a power of ten, you *first count all the decimal places including the 1.*

The number forming the exponent is the same number as the number of decimal places. Now write ten with the exponent. There is one important difference though. Write the exponent *with a* ***negative sign*** *in front of it to indicate that the number is a decimal number***.**

Example: Write .00001 as a power of ten.

There are five decimal places after the decimal point. Write ten and the exponent five with a negative sign.

.00001 = 10^{-5}

Example: Write .0000001 as a power of ten.

There are seven decimal places after the decimal point. Write ten with the exponent -7.

.0000001 = 10^{-7}

Example: Write .1 as a power of ten.

There is one decimal place.

.1 = 10^{-1}

MULTIPLYING AND DIVIDING POWERS OF TEN

Powers of ten written with exponents are easier to read and keep track of than the longer forms of the numbers. As a bonus, the exponents written with the base ten have some special characteristics. When you multiply and divide powers of ten, you can use a shortcut.

Multiplying powers of ten

To multiply powers of ten:

1. Add the exponents together and
2. use that addition answer as the new exponent of the multiplication answer.

Example: Multiply $10^3 \times 10^5$

1000 x 10 0000 = 100 000 000
$10^3 \times 10^5 = 10^8$

You can multiply 1000 (10^3) x 100 000 (10^5) to get 100 000 000 and rewrite it as 10^8. *Or you can simply add the exponents together*. This gives you the exponent of the multiplication answer. To multiply $10^3 \times 10^5$, add the exponents 3 + 5, which equals 8. The exponent of the answer is 8.

$10^3 \times 10^5 = 10^8$

The answers are the same but the second method is faster and it is easier to keep track of the zeros.

Example: Multiply $10^7 \times 10^9$.

Add the exponents together. The addition answer becomes the new exponent of the multiplication answer. You can add the exponents in your head.

$10^7 \times 10^9 = 10^{16}$ (7 + 9 = 16)

Dividing powers of ten

To divide powers of ten

To divide using powers of ten:

1. *Subtract the exponent of the divisor from the exponent of the dividend; and,*
2. Use that answer as the new exponent.

In the division 100÷10, 100 is the ***dividend***, the number you divide into, and 10 is the ***divisor***, the number you divide by.

Example: $10^{12} \div 10^6$

You could divide the long forms and rewrite the answer as 10^6.

$$1{,}000{,}000 \overline{)1{,}000{,}000{,}000{,}000} = 1{,}000{,}000 = 10^6$$

Or you could subtract the exponents and use the subtraction answer as your new exponent.

$10^{12} \div 10^6 = 10^6$ (12 - 6 = 6)

Example: $10^{15} \div 10^4$

Subtract the exponents and use your subtraction answer as your new exponent. You can do the subtraction of exponents in your head.

$10^{15} \div 10^4 = 10^{11}$ (15 – 4 = 11)

Remember: *Decimal numbers expressed as powers of 10 have a negative sign in front of the exponent.*

To multiply and divide powers of ten with negative exponents, you need to know the rules for adding integers.

Working with Integers

Integers *include all numbers with* ***positive*** *or* ***negative*** *signs*. A negative number always has a negative sign in front of it. If there is no sign in front of a number, it is assumed to be a positive number.

When working with integers, we consider addition as another positive sign and subtraction as another negative sign. If you are adding or subtracting integers, a − or + sign is placed in front of the number to be added or subtracted. This number will already have a positive or negative sign.

Before doing the operation, simplify the terms so there is only one sign in front of each number.

Here are the rules that tell you what sign to leave in front of each number:

- If there is both a − sign and a + sign, the sign becomes −.
- If there are two + signs, the sign is +.
- If there are two − signs, the sign becomes +.

Example: Simplify $-8 + (-5) - (-7)$

Use the rules given so that there is only one sign in front of each number.
– 8 stays the same
+(– 5) becomes – 5
−(– 7) becomes +7

So
-8 + (−5) − (−7)
= −8 − 5 + 7

Once you simplify the equation so there is only one sign in front of each number, the operation is considered as ***addition*** with positive and negative numbers. You then add the signed numbers following the rules below for adding integers.

Adding integers

Rule 1: *To add two positive numbers, **find the sum of their values and write the answer***. The positive sign in the answer doesn't have to be shown.

Add $4 + 7 = 11$

Rule 2: *To add two negative numbers, add the* **value of the numbers** *together and write the answer with a* **negativ***e sign in front*.

Add $\begin{array}{r} -8 \\ -\underline{14} \\ -22 \end{array}$ or $-8 + (-14) = -22$

Rule 3: *To add a negative and a positive number, **subtract the number with the smaller value from the number with the larger value***. Give the answer the sign of the number with the ***larger*** value.

Add $\begin{array}{r} -8 \\ \underline{5} \\ -3 \end{array}$ $\begin{array}{r} 10 \\ -\underline{7} \\ 3 \end{array}$ $\begin{array}{r} 8 \\ -\underline{9} \\ -1 \end{array}$

Or $\begin{aligned} &-8 + 5 \\ &= -3 \end{aligned}$ $\begin{aligned} &10 + (-7) \\ &= 10 - 7 \\ &= 3 \end{aligned}$ $\begin{aligned} &8 + (-9) \\ &= 8 - 9 \\ &= -1 \end{aligned}$

Example: $10^{-8} \times 10^{2}$

Multiply the powers of ten by adding the exponents $-8 + 2$.
Follow Rule 3: When adding a positive and a negative number, subtract the number with the smaller value (2) from the number with the larger value (-8). ($8 - 2 = 6$) Give the answer the sign of the number with the larger value. Since -8 has the larger value, the sign of the answer will be negative.

$-8 + 2 = -6$

Write the answer to the addition question as the exponent to the base 10, keeping the negative sign.

$10^{-8} \times 10^{2} = 10^{-6}$

Example: $10^{-3} \div 10^{-6}$

Both exponents are negative numbers, follow the rules for simplifying signs and adding integers.

First write the exponents with their signs as a subtraction question.

$-3-(-6)$

Write each number with one sign, following the rules for simplifying signs.

$-3+6$

Follow Rule # 3 for adding integers.

$-3+6=3$

Write the answer as the exponent to base 10.

$10^{-3} \div 10^{-6} = 10^{3}$

Summary: Writing large numbers like 100 000 000 or .0001 as a power of ten makes it easier to keep track of all the zeros. It is also easier to multiply and divide when the numbers are written as powers of ten.

Here are some questions on powers of ten. **Answers are at the end of this manual..**

1. In the number 3^2, the 3 is called a ______________ or ______________, and the small 2 to the right of and slightly above the three is called the _________________ .
2. 2^5 can be written as ___ x ___ x ___ x ___ x ____ .
3. Numbers with exponents that use ten as their base are called ____________ of ______ .
4. 10^4 is read as ten to the _____________ .
5. 10^2 means to multiply _____ x _____. 10^2 is equal to _______ .
6. To write 10^4 in long form, we write a one with _________ zeros after the one. 10^4 written in long form is ____________ .
7. 10^7 written in long form is _______________ .
8. 1 000 000 written as a power of ten is _____________ .
9. 1 000 written as a power of ten is ____________ .
10. 10^{-2} written in long form is ____________ .
11. 10^{-5} written in long form is ______________ .
12. 10^{-1} written in long form is ___________ .
13. .001 written as a power of ten is ____________ .
14. .000001 written as a power of ten is ______________ .
15. 10 000 000 000 written as a power of ten is ______________ .
16. Multiply (write your answers as powers of ten):

    a) 10^3 x 10^4 = ___________ b) 10^1 x 10^5 = ___________

    c) 10^6 x 10^{-4} = __________ d) 10^0 x 10^8 = ___________
17. Divide (write your answers as powers of ten):

    a) $10^{10} \div 10^7$ = _________ b) $10^5 \div 10^2$ = ___________

    c) $10^9 \div 10^{-7}$ = _________ d) $10^5 \div 10^0$ = ___________

PART II SQUARES and SQUARE ROOTS

SQUARING A NUMBER

Instructions asking you to square a number can say *"find the square of a number"* or *"square a number"*. Both instructions ask you to do the same calculation. The *square of the number* refers to the answer after you have multiplied it by itself. *Square a number* means to multiply the number by itself.

T*he **square of a number** is the number multiplied by itself.*

To find the square of 5, multiply 5 by itself.

5 x 5 = 25

You can also say 5 squared equals 25; it means the same as multiplying 5 by 5.

The square of 10 is 100 (10 x 10).
The square of 6 is 36 (6 x 6)

When the exponent ^{2} follows a number, it indicates that the number is to be squared. Five squared can be written as 5^2. So:

5^2 = 5 x 5 = 25
20^2 = 20 x 20 = 400
10 squared (10^2) is 10 x 10 = 100
The square of 9 (9^2) is 9 x 9 = 81

Squares of the Numbers One to Twelve

It is a good idea to memorize the squares of the numbers up to 12. You are probably familiar with most of them. Here is a list:

1 x 1 = 1	7 x 7 = 49
2 x 2 = 4	8 x 8 = 64
3 x 3 = 9	9 x 9 = 81
4 x 4 = 16	10 x 10 = 100
5 x 5 = 25	11 x 11 = 121
6 x 6 = 36	12 x 12 = 144

Go over the list to learn these square roots. Cover up the answers and say them to yourself, or write out the list and check your answers. Practice until they are memorized.

Finding the Square of a Larger Number

It is helpful to know and recognize the squares of the numbers to twelve. When working with larger numbers, though, you will have to multiply on paper or use a calculator to find their squares.

Example: Find the square of 25.

```
   25
 x 25
  125
   50
  625
```

The square of 25 is 625.

Squaring a Fraction or Decimal
To square a fraction or decimal, do the same thing. Multiply the fraction or decimal by itself.

Example: Square 3/4

3/4 x 3/4 = 9/16

Example: Square 9.1

```
  9.1
x 9.1
   91
  819
82.81
```

When the exponent ^{2} is used to indicate that you are to square a fraction or decimal, you write the number in brackets first.

3/4 squared is written $(3/4)^2$
9.1 squared is written $(9.1)^2$

The brackets indicate that the entire number is to be squared.

- You could also have $\frac{3^2}{4}$, which means only the top part of the fraction, the numerator, is to be squared.
- The fraction $\frac{3^2}{4}$ would become 9/4 when the 3 is squared.

Remember: *To do questions involving several mathematical operations including exponents, do the operations in order. The letters which make up the term BEDMAS will give you the correct order of operations.*

BEDMAS
1. **B**rackets → make calculations inside brackets
2. **E**xponents → calculate any numbers with exponents
3. **D**ivision → do any division and
4. **M**ultiplication in the order in which they appear from left to right
5. **A**ddition → do any addition and
6. **S**ubtraction in the order in which they appear from left to right

Squaring Units
When you square a quantity such as 6 meters, which has a measurement unit (meters) attached, the unit (meters) is also squared.

If you multiply 6 m x 6 m, you multiply 6 x 6 but you also multiply the meters times meters. This gives square meters or meters squared.

6m x 6m = 36m^2

Square units can be indicated in more than one way.

- The exponent ^{2} can be written after the unit like this, m^2.
- Squared units can also be written with the abbreviation sq for square like this, *sq ft*.

Area
Units of area are always squared units.

Area is found by multiplying two measurements of length, with their units.
- To find the area of a rectangle, you multiply length times width.
- To find the area of a triangle, you multiply the base times the height times ½.
- In each case, the units of the measurements are multiplied by themselves or squared.

Note: *To find area, both measurements must have the same units before they can be multiplied. You can't find the area of a rectangle with a length of 138 centimeters and a width of .75 meters. One of the units must be changed so they are both the same.*
- You could choose to change the units of measure so they are both centimeters (.75m x 100 = 75 cm), then multiply (138 cm x 75cm = 10350 cm^2).
- Or, you could make them both meters (138cm ÷ 100 = 1.38m) then multiply (75m x 1.38m = 103.5m^2).

Example: Square 15 meters

15 m x 15 m
= 225 m^2

Example: Find the square of 100 miles.

100 mi x 100 mi
= 10 000 sq mi or mi^2

Example: Find the area of a rectangle with all its sides measuring 4 ft.

4 ft x 4 ft
= 16 sq ft

You probably recognized that a rectangle with all its sides the same length is known as a ***square*** (another use of that term).

Example: What is the area of a square with sides that measure 1 m?

1 m x 1 m
= 1 m^2

This example seems a little strange but 1 x 1 = 1. The difference in the answer is that the units are now squared.

Note: *Notice the difference between 9 sq yd and 9 yards square.*

- An area of 9 sq yd can have any shape as long as it has a total area of 9 yd^2.
- An area 9 yards square has the shape of a square and its length and width are each 9 yards long. The area that is 9 yards square is 9 yd x 9 yd or 81 sq yd.

Usually we have to find the area of a space that is not square. To do this we multiply the length and width to get the numerical answer. *We still have to square the units.*

Example: Find the area of a rectangle that is 3 inches by 20 inches.

3 in x 20 in square the units of measurement
= 60 sq in

Example: Find the area of a rectangle that has a length of 1.2 meters and a width of 70 centimeters.

You have to change one of the measurements so that it has the same unit as the other one. Change centimeters to meters.

70 cm = .7 m

Now multiply.

1.2 m x .7 m
= .84 m^2

FINDING SQUARE ROOT

The ***square root*** *of a number is that number which when multiplied by itself produces the given number.*

This definition sounds rather wordy. It might be easier to understand the meaning of square root by looking at an example. The square root of 81 is 9 because 9 multiplied by itself equals 81.

The symbol $\sqrt{\ }$ indicates you are to find the square root. So $\sqrt{81} = 9$ is read as "the square root of 81 equals 9."

Finding the square root is the opposite of squaring a number. Squaring a number is multiplying that number by itself. To find the square root of a number, you consider the given number as a square. *You are looking for the number you multiplied by itself to get that square*.

To find the square root of 64:

1. First consider that some number has been squared (multiplied by itself) to get 64.
2. Now you have to find that number.
3. From the table on the first page, you know that 8 x 8 = 64, so the square root of 64 is 8.

It is important to know the squares of the numbers up to twelve so you can recognize the square roots. The square root of 144 is 12, the square root of 100 is 10 and the square root of 16 is 4. Here is the table giving these common square roots:

$\sqrt{1} = 1$	$\sqrt{49} = 7$
$\sqrt{4} = 2$	$\sqrt{64} = 8$
$\sqrt{9} = 3$	$\sqrt{81} = 9$
$\sqrt{16} = 4$	$\sqrt{100} = 10$
$\sqrt{25} = 5$	$\sqrt{121} = 11$
$\sqrt{36} = 6$	$\sqrt{144} = 12$

You will often have to use these square roots, so it is a good idea to memorize them.

Some square roots are not so perfect

A perfect square is a number that has a whole number which is its square root. You can see from the chart above that if you were asked for the square root of a number like 40 or 75, the answer would not be a whole number. In fact, you can guess that finding an exact square root of a number like that might be almost impossible.

Still, you might have to find the square root of a number when you don't have a clue what number was multiplied by itself to give that square. Here is a way to find a good approximation, to the nearest tenth, of the square root of a number smaller than 144.

Example: To find $\sqrt{75}$ follow these steps:

Step 1. Find a whole number whose square is close to but smaller than 75. In this case, $8^2 = 64$, so 8 is a first guess.

Step 2. Divide the guessed number into the original number. Carry the division to two decimal places.

$$8\overline{)75.00} = 9.37$$

Step 3. Take the average of the guessed number (8) and the answer to the division question (9.37). You find an average by adding all the numbers together and then dividing the addition answer by however many numbers you added together.

$$\frac{8+9.37}{2} = 8.685$$

Check your answer.

```
     8.685
     8.685
     43425
    694800
   5211000
  69480000
 75.429225
```

That is pretty close.

$\sqrt{75}$ is about 8.685

Many of these answers will go on to several decimal places. You can get a good enough approximation by working each answer to two decimal places or to the nearest hundredths. Then round off the final answer to one decimal place or the nearest tenth. The answer above, 8.685, when rounded off to the nearest tenth, becomes 8.7

To check your answer, square it to see if it is close to the square root. They should be almost the same number.

8.7 x 8.7 = 75.69

8.7 is a reasonable approximation of $\sqrt{75}$.

Square root of a number with units

If you are finding the square root of a number with units, the units will be squared units. When you find the square root, the units will no longer be squared.

Example: Find the square root of 121 m^2.

$$\sqrt{121m^2} = 11m$$

Using a Calculator

Finding the square root of a number larger than 144 requires a long procedure. It makes sense to find the square root of larger numbers by using a calculator.

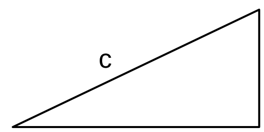
Key in the number you need to find the square root of, then press the square root symbol.

If you have to do problems that involve square roots without a calculator and the square root isn't one that is easily recognized, you can leave the answer under the square root symbol.

Example: Find the length of c in the right angle triangle below if *a* is 6 cm and *b* is 7 cm.

$a^2 + b^2 = c^2$
$6^2 + 7^2 = c^2$
$c^2 = 36 + 49$ (reverse the equation)
$c^2 = \underline{85}$

$c = \sqrt{85}$ cm

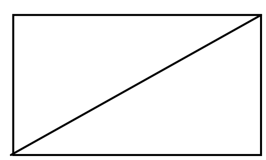


The answer can be left as $\sqrt{85}$ cm

However, if you are using this formula to check if a rectangular foundation is laid out so the corner angles are true 90° angles, you need to find the numerical value of the square root. Use a calculator to do this.

Example: If the length of the bottom of a box is 60 cm and the width is 40 cm, what should the distance across the diagonal be if the corners are true 90° angles?

$c^2 = a^2 + b^2$
$c^2 = 60^2 + 40^2$
$c^2 = 3600 + 1600$
$c^2 = 5200$
$c = \sqrt{5200}$
$c = 72.1$ cm



The distance across the diagonal should be 72.1 feet if the foundation is a true rectangle.

Here are some questions on squares and square roots. The answers are on the last page.

18. Square each of the following numbers:

a) 4 b) 10 c) 12 ft d) 30 m e) 425

f) .5 g) 6.2 h) 2/3 g i) 8 1/4 in

19. Find the value of the following:

a) 3^2 b) $(15 \text{ cm})^2$ c) $(2/5)^2$ d) 1.6^2

20. Find the square root to the nearest tenth:

a) 64 b) 144 c) 100 km^2 d) 16 sq mi e) 31 f) 92

21. Find the value to the nearest tenth:

a) $\sqrt{9}$ b) $\sqrt{100}$ c) $\sqrt{49}$ d) $\sqrt{25\text{m}^2}$

e) $\sqrt{4}$ f) $\sqrt{1 \text{ ft}^2}$ g) $\sqrt{45}$ h) $\sqrt{56}$ i) $\sqrt{110}$

ANSWER PAGE
PART I POWERS OF TEN

1. factor or base, exponent

2. 2 x 2 x 2 x 2 x 2

3. powers of ten

4. fourth

5. 10 x 10, 100

6. four, 10 000

7. 10 000 000

8. 10^6

9. 10^3

10. .01

11. .00001

12. .1

13. 10^{-3}

14. 10^{-6}

15. 10^{10}

16. a) 10^7 b) 10^6

 c) 10^2 d) 10^8

17. a) 10^3 b) 10^3

 c) 10^{16} d) 10^5

PART II SQUARES AND SQUARE ROOTS

18. a) 16 b) 100 c) 144 sq ft d) 900 m^2

e) 180 625 f) .25 g) 38.44 h) 4/9 g^2

i) 64 1/16 sq in

19. a) 9 b) 225 cm^2 c) 4/25 d) 2.56

20. a) 8 b) 12 c) 10 km d) 4 mi

e) 5.6 f) 9.6

21. a) 3 b) 10 c) 7 d) 5 m

e) 2 f) 1 ft g) 6.7 h) 7.5 i) 10.5