S1 Units Conversions

Suppose you have two Units of Measurement

U_1 and U_2 and you wish to convert from one unit to the other, for example cm and inches

For example, you want to convert 23.4 cm to inches

First, you must determine the conversion number.

You may look this up in some type of unit conversion table, or you can go to www.WolframAlpha.com and get the answer or find the conversion number.

WA1 Convert 1 cm to inches

Answer: 1 cm = .3937 inches

Now, you have 23.4 cm = X inches and you want X.

Multiply both sides by 23.4 and get

23.4 cm = 23.4x.3937 inches = 9.2 inches

Of course, we could have gotten this directly from www.wolframalpha.com

WA2 Convert 23.4 cm to inches

Answer: 9.213

Suppose you wanted to convert 15.7 inches to cm?

1 cm = .3937 inches same as 1/.3937 cm = 1 inch

Or 1 inch = 2.54 cm   since 1/.3937 = 2.54

Then, 15.7 inches = 15.7x2.54 cm = 39.88 cm

Of course,

WA3 convert 1 inch to cm

Answer: 2.54

WA4 convert 15.7 inches to cm

Answer: 39.88

This type of process applies to any type of conversion of units. Of course, the units must be measuring the same thing like length or weight.

Example 1: convert 18.3 grams to ounces

First you must find a conversion factor for grams to ounces: 1 gm = .0353 oz you find somewhere.

Then, 18.3 gm = .0353x18.3 oz = .646 oz

WA5   1 gram to ounce   Ans: .03527

WA6   18.3 gram to ounce   Ans: .6455

The same process applies to any type of unit conversion.

For example, square feet to square meters

1 sq meter = 10.76 square feet

Thus, 1 square foot = 1/10.76 sq m = .093m^2

Example 2: 4.7 sq m are how many sq ft?

Ans: 4.7x10.76 ft^2 = 50.57 ft^2

WA7 4.7 sq m to sq ft Ans: 50.6

To get more accuracy

WA8 4.70 sq m to sq ft Ans: 50.59

WA9 1 square meter to square feet Ans: 10.76

Example 3: 12.3 Kilograms is how many pounds?

WA10 12.3 kilograms to pounds

Ans: 27.12 lb = 27 lb 1.9oz

Example: 3.4 cubic meters is how many cubic yards

1 m = 1.094 yd

1 m^3 = 1.094^3 yd^3 = 1.309 yd^3

So 3.4 cu m = 3.4x1.309 cu yd = 4.45 cu yd

WA11 3.4 cubic meter to cubic yard

Ans: 3.45 cu yd

In general, if you have two units which measure the same quantity, U_1 and U_2 and you wish to convert from one unit to the other, then

If you have access to www.wolframalpha.com you simply enter the command

convert N U_1 to U_2

where N is the amount of the quantity you have expressed in U_1 and you will get the amount expressed in U_2

If you don't have access to Wolfram Alpha, then you must find the conversion factor C where

$1\ U_1 = CU_2$

Multiply both sides by N to obtain the answer

$N\ U_1 = CxN\ U_2$

Example: you know 1 mile = 1.609 kilometers

60 miles = 1.609x60 km = 96.54 km

So, you can see for example that

100 km/hr is about 60 m/hr.

S1 Units Conversion Exercises

Q1. Given the conversion factor 1 ft = 12 in, how many inches are in 1.5 ft?

Q2. Given the conversion factor 1 ft = 12 in, how many feet are in 14 in?

Q3. Given the conversion factor 1 m = 39.37 in, how many inches are in 2.8 m?

Q4. Given the conversion factor 1 m = 39.37 in, how many meters are in 76 in?

Q5. Given the conversion factor 1 in^2 = 6.452 cm^2, how many cm^2 are on an 8 ½ in x 11 in sheet of paper?

Q6. Given the conversion factor 1 in^2 = 6.452 cm^2, how many in^2 are in 100 cm^2?

Q7. Given the conversion factor 1 gal = 3.785 l, how many liters are in 19 gal?

Q8. Given the conversion factor 1 km^2 = 0.3861 mi^2, how many mi^2 are in 15 km^2?

Q9. Given the conversion factor 1 gal = 3.785 l, how many gallons are in 2 l?

Q10. If I want to pour a concrete house slab that is 52 feet long by 28 feet wide by 4 inches deep, how would I determine how many cubic yards of concrete would be needed?

A1. 1 ft = 12 in (You will also see this written as 12 in/ft.)

1.5 ft = X in

(12 in/ft)*(1.5 ft) = 18 in

or

WA convert 1.5 ft to in

18 in

A2. 1 ft = 12 in

1/12 ft = 12/12 in

0.0833 ft = 1 in (You will also see this written as 0.0833 ft/in.)

14 in = X feet

(0.0833 ft/in)*(14 in) = 1.167 ft

or

WA convert 14 in to ft

1.167 ft

A3. 2.8 m = X in

(39.37 in/m)*(2.8 m) = 110.24 in

A4. 1 m = 39.37 in

1/39.37 m = 39.37/39.37 in

0.0254 m = 1 in (You will also see this written as 0.0254 m/in.)

76 in = X m

(0.0254 m/in)*(76 in) = 1.930 m

or

WA convert 76 in to m

1.93 m

A5. (8 ½ in)*(11 in) = 93.5 in^2

$(6.452\ cm^2/in^2)*(93.5\ in^2) = 603.262\ cm^2$

or

WA convert 93.5 inches^2 to cm^2

603.2 cm^2

or

WA convert (8.5 inches)*(11 in) to cm^2

603 cm^2

Note: The answers are actually the same. The slight differences occur during rounding.

A6. $1\ in^2 = 6.452\ cm^2$

$1/6.452\ in^2 = 6.452/6.452\ cm^2$

$0.155\ in^2 = 1\ cm^2$ (You will also see this written as 0.155 in^2/ cm^2.)

$100\ cm^2 = X\ in^2$

$(0.155\ in^2/\ cm^2)*(100\ cm^2) = 15.5\ in^2$

or

WA convert 100 cm^2 to in^2

15.5 in^2

A7. 19 gal = X l

(3.785 l/gal)*(19 gal) = 71.915 l

or

WA convert 19 gal to l

71.92 L

A8. 15 km^2 = X mi^2

(0.3861 mi^2/km2)(15 km^2) = 5.7915 mi^2

or

WA convert 15 km^2 to mi^2

5.792 mi^2

A9. 1 gal = 3.785 l

1/3.785 gal = 3.785/3.785 l

0.2642 gal = 1 l (You will also see this written as 0.2642 gal/l.)

2 l = X gal

(0.2642 gal/l)*(2 l) = 0.5284 l

or

WA convert 2 l to gal

0.5283 l

A10. 27 ft^3 = 1 yd^3

27/27 ft^3 = 1/27 yd^3

1 ft^3 = 0.0370 yd^3

1 ft = 12 in

1 in = 0.0833 ft. (See A1 for math conversion.)

First, convert in to ft.

4 in = X ft

(0.0833 ft/in)(4 in) = 0.3332 ft

Next, calculate number of ft^3.

(52 ft)(28 ft)(0.3332 ft) = 485.1392 ft^3

Finally, convert ft^3 to yd^3.

$$485.1392\ ft^3 = X\ yd^3$$

$$(0.0370\ yd^3/ft^3)(485.1392\ ft^3) = 17.968\ yd^3$$

S2 DMS Degrees – Minutes – Seconds

There are 360^o or Degrees in one revolution or circle.

In the DD system we express degrees with decimal notation. 37.45 degrees means 37 and 45/100 degrees

In the DMS system, 1 degree = 60 minutes, or 1^o = 60’

And 1 minute = 60 seconds, or 1’ = 60”

So, 1’ = $(1/60)^o$ and 1” = (1/60)’ = $(1/3600)^o$

We can express degrees in either DD or DMS format and convert degrees from DD to DMS and DMS to DD using the TI30Xa calculator.

DMS → DD is 2^{nd} +

DD → DMS is 2^{nd} =

Example:

6.5^o = 6^o 30’ 00”00

6.55^o = 6^o 33’ 00”00

6.57^o = 6^o 34’ 12”00

6.573^o = 6^o 34’ 22”80 this means 22.80”

127.875^o = 127^o 52’ 30”

57.382^o = 57^o 22’ 55”2 this means 55.2”

To apply the DMS → DD conversion you must enter the angle in the following format

6^o 34’ 22”80 is entered 6.342280 2^{nd} + 6.573^o

26^o 4’ 2”50 is entered 26.040250 2^{nd} +
Answer: 26.06736^o

Now enter 26.06736^o and get 26^o 04’ 02”5

It is possible to do these conversions manually with formulas, but it is best to do it with a calculator

S2 DMS Degrees – Minutes – Seconds Exercises

Convert the following decimal degree (DD) numbers to degrees-minutes-seconds (DMS).

Q1. 87.625

Q2. 137.6489

Q3. 65.475698

Q4. 19.01325

Q5. 45.4557

Convert the following degrees-minutes-seconds (DMS) to decimal degree (DD) numbers.

Q6. 66°18’12”0

Q7. 78°45’06”4

Q8. 180°04’07”

Q9. 97°09’45”7

Q10. 54°57’27”4

A1. 87°37’30”00

A2. 137°38’56”

A3. 65°28’32”5

A4. 19°00’47”7

A5. 45°27’20”5

A6. 66.30333333

A7. 78.75177778

Note: If you get an answer of 78.75167778, what you did is enter into your calculator “78.450604” instead of “78.45064” before you hit the DMS → DD key. Anything after the “ symbol, in this case 06”4, should be treated as 6.4 seconds, therefore, entering a 0 before the 4 would be incorrect.

A8. 180.0686111

A9. 97.162269444

Note: If you get an answer of 97.16251944, what you did is enter into your calculator “97.094507” instead of “97.09457” before you hit the DMS → DD key.

A10. 54.95761111

Note: If you get an answer of 54.95751111, what you did is enter into your calculator “54.572704” instead of “54.57274” before you hit the DMS → DD key.

S3 y^x Exponents

y^x means y times itself x times

y is called the base,

x is called the exponent

Examples:

$2^3 = 8$; $3^2 = 9$; $5^4 = 625$; $10^5 = 100{,}000$

The y^x key is the east way to calculate this.

Clear the calculator

Enter 2 and press the y^x key

Enter 3 and press the = key Ans: 8

Do all of the above.

y can be any positive number

x can be any number

$\sqrt[x]{y}$ means the x^{th} root of y

same as $y^{(1/x)}$ $[\sqrt[x]{y}]^x = y = \sqrt[x]{(y^x)}$

$\sqrt[3]{8} = 2 = 8^{1/3}$

$1.7^{2.7} = 4.19$

$2^{10} = 1024$ Kilo $\sqrt[10]{1024} = 2 = 1024^{1/10}$

Metric		Digital
$10^3 = 1000$	Kilo	$2^{10} = 1024$
$10^6 = 1,000,000$	Mega	$2^{20} = 1,048,576$

$10^9 = 1,000,000,000$ Giga Metric

$2^{30} = 1,073,741,824$ Giga Digital

$10^{12} = 1,000,000,000,000$ Tera Metric

$2^{40} = 1,099,511,627,776$ Tera Digital

Compound interest at 5% for 40 years

$1.05^{40} = 7.04$

$1.06^{40} = 10.3$

$1.25^{25} = 265$ Kmart growth rate 25% / yr

$1.56^{25} = 67,315$ Walmart growth rate 56% / yr

$(1 + 1/1,000,000)^{1,000,000} = 2.718 = e$

Negative exponents

$y^{-x} = 1 / y^x$

$9^{-2} = 1 / 9^2 = 1 / 81 = .012345679$

$9^{-1/2} = 1 / 3 = 1 / 9^{1/2}$

$5.7^{-1.3} = .104$

$.58^{-3.2} = 5.715$

$-3^{.5}$ = Error

Exponents are very common in many situations. The calculator makes it very easy to deal with them. Just follow the rules.

Of course, Wolfram Alpha also will deal with them very easily.

S3 Exponents Exercises

Use your calculator to solve the following exercises.

Q1. 4^{7} =

Q2. 10^{9} =

Q3. $4.2^{3.6}$ =

Q4. $\sqrt[8]{256}$ =

Q5. $\sqrt[6]{1{,}000{,}000}$ =

Q6. $\sqrt[3.2]{8.3}$ =A1. 16,384

Q7. 7^{-2} =

Q8. $56^{-2.4}$ =

Q9. $0.47^{-3.1}$ =

Q10. If production increases at a rate of 6.5%/year, what is your production after 15 years?

Q11. If production increases at a rate of 7.5%/year, what is your production after 15 years?

Q12. For the following exponents, match them with their name

1. 10^{3} = 1,000	a. Giga (Digital)
2. 10^{6} = 1,000,000	b. Tera (Digital)
3. 10^{9} = 1,000,000,000	c. Giga (Metric)
4. 10^{12} = 1,000,000,000,000	d. Tera (Metric)
5. 2^{10} = 1,024	e. Mega (Metric)
6. 2^{20} = 1,048,576	f. Kilo (Metric)
7. 2^{30} = 1,073,741,824	g. Mega (Digital)
8. 2^{40} = 1,099,511,627,776	h. Kilo (Digital)

A1. 16,384

A2. 1,000,000,000

A3. 175.266

A4. 2

A5. 10

A6. 1.937

A7. 0.020

A8. 0.0000637

A9. 10.387

A10. $1.065^{15} = 2.572$

A11. $1.075^{15} = 2.959$

A12. 1f, 2e, 3c, 4d, 5h, 6g, 7a, 8b

S4 Density = Weight / Volume

How much does 55 gallons of water weigh (in lbs)?

How much does 55 gallons of gasoline weigh?

How much does 55 gallons of cement weigh?

How much does 55 gallons of mulch weigh?

Weight is measured in units such as:

Grams (gm), pound (lb), ounce (oz),

kilograms (kg), stone (st), etc

Volume is measured in such units as:

gallons(gal), quarts (qt), fluid ounces (fl oz),

liters (ltr), cubic inches (cu in or in^3),

cubic feet (cu ft or ft^3) or in general

cubic U (cu U or U^3) where U is a linear length, etc.

Suppose 1 gallon of water weighs 8.345 lbs

Then, 55 gallons would weigh 55x8.345 = 459 lbs

How do you find out what 1 gallon of water weighs?

Well, you could weigh a quart of water and multiply by 4 since 4 quarts equals one gallon.

Or, you could weigh 1 oz of water and multiply by 128 since one gallon is 128 oz.

Or, you could weigh a container full of water whose volume is 12 oz and then multiply by 128/12

Of course, you must subtract the weight of the empty container!

The Density of water is what you are computing.

Density = Mass/Volume = Weight/Volume

D = W/V or W = DV or V = W/D

So, if you know any two of these, then you always can calculate the third.

The units must always match up.

If W is lb and V is ft^3, the D must be lb/ft^3

D could be lb/gal, or oz/quart, or gm/liter, etc.

Above we determined a W and V in an experiment and calculated D, and then used this D to calculate the W when we were given the V.

What you always want to do first is learn the D for a substance.

For example, D for gasoline is 6.06 lb/gal

So, 55 gallons of gasoline would weigh

55x6.06 = 333 lbs   VxD = W galx(lb/gal) = lb

BUT, how do we know D for gasoline.

1. **We could look it up in some table of density's.**
2. **We could find out on the Internet. My favorite is www.WolframAlpha.com**
3. **We could do the experiment by weighing a known volume, usually pretty small.**

WA1   density of gasoline in lb/gal

Ans: 6.06 lb/gal

But, suppose you did the experiment and found that 24.7 cu in of gasoline weighed 10.4 oz?

10.4/24.7 = .42 oz/in^3 convert this to lb/gal

WA2 convert .42 oz/in^3 to lb/gal

Ans: 6.06 lb/gal   as it should be.

Note: Do you think I actually did this experiment?

Of course not, I just used WA backwards

WA3 convert 6.06 lb/gal to oz/in^3

Ans: .42 oz/in^3

But, in many cases, you won't be able to find the Density of a substance in any handbook, or even on Wolfram Alpha. So then, you simply must do the experiment with a convenient container.

1. **Compute its volume.**
2. **Fill it up with the substance.**
3. **Calculate the Density of this substance.**

Then you can find either V or W if you know the other one.

For example, how many cubic yards will one ton of insulation material fill up?

Suppose we do the experiment and find that the density of some insulation material is 2.5 lbs/gal. (I have no idea what it really would be.)

Then, WA tells us the density would be:

WA4 convert 2.5 lbs/gal to lbs/yd^3

Ans: 505 lbs/cu yd

So, V = W/D yields 2000/505 = 4 yd^3 as answer.

How much does 55 gallons of cement weigh?

WA5 density of cement in lb/gal

Ans: 16.8 lb/gal

So 55 gallons weighs 55x16.8 = 924 lbs

If in doubt, actually do the experiment and weigh a small amount and then do the calculations.

How much does 55 gallons of mulch weigh?

WA6 density of mulch in lb/gal

WA doesn't know. You will probably just have to do the experiment and calculate the density.

So now, you can do a bunch of problems.

Sometimes, WA will give you the density.

Sometimes you will have to find it by experiment.

Use some handy container whose volume you know or can compute. And, fill it up and weight it. Subtract the empty container weight.

Then, use WA to convert it to the Units you want.

S4 Density = Weight / Volume Exercises

Use your calculator to solve the following exercises.

Q1. 1 quart of seawater (salt water) weighs 2.138 lb. What is the density of seawater (lb/gal)?

Q2. The density of propane is 0.0156843 lb/gal. A residential tank holds 250 gal. of propane. What is the weight (lb) of the propane in that tank?

Q3. The density of gold is 11.2 oz/ in^3. What is the volume (in^3) of 16 oz. (or 1 lb) of gold?

Q4. A quart of whole milk weighs 2.3 lb. What is the density (gal) of whole milk in lb/gal?

Q5. An adult is recommended to limit their salt intake to no more than 2300 mg per day. If the density of salt is 10,600 mg/tsp (teaspoons), what is the volume of salt (tsp) an adult should not exceed per day?

Q6. A grass catcher for a mower holds 4.4 ft^3 of grass. If the density of grass is 17.4 lb/ ft^3, what is the weight (lb) of the grass in the catcher?

Q7. You buy a pool which is 24 ft in diameter and fills with water to 4 ft deep. The density of water is 8.345 lb/gal. How much does the water in your pool weigh (lb)? Useful information: 1 ft^3 = 7.481 gal.

Q8. A ream (500 sheets) of 8.5 in x 11 in standard office paper is 2 in thick, and weighs 5 lb. What is the density of the paper (oz/in^3)? Useful information: 1 lb = 16 oz.

Q9. If 1 lb of feathers has a density of 0.0025 g/cm^3, what is the volume of those feathers (cm^3 and ft^3)? Useful information: 1 lb = 453.6 g; 1ft^3 = 28,317 cm^3

Q10. A bag of concrete mix weighs 80 lb. and has a dry volume of 0.53 ft^3. If 4 liters (L) of water are added to the mix, what is the final weight (lbs.) of the concrete? Also, what is the final volume (ft^3) that the bag will fill once mixed with water? Use these numbers to calculate the density (lb/ft^3). Useful information: Density of water: 1000 g/L (grams/liter); 1 lb = 453.6 g; 1 L = 0.03531 ft^3

A1. $D = W/V$

$D = 2.138$ lb/1 quart

$D = (2.138$ lb/quart$)\text{x}(4$ gal/quart$)$

$D = 8.552$ lb/gal

A2. $W = VD$

$W = (250$ gal$)\text{x}(0.0156843$ lb/gal

$W = 3.92$ lb

A3. $V = W/D$

$V = (16 \text{ oz})/(11.2 \text{ oz/in}^3)$

$V = 1.43 \text{ in}^3$

A4. $D = W/V$

$D = 2.13$ lb/1 quart

$D = (2.3$ lb/quart$)\text{x}(4$ gal/quart$)$

$D = 9.2$ lb/gal

A5. $V = W/D$

$V = (2300 \text{ mg})/(10{,}600 \text{ mg/tsp})$

$V = 0.217$ tsp

A6. $W = VD$

$W = (4.4 \text{ ft}^3)\text{x}(17.4 \text{ lb/ ft}^3)$

$W = 76.6$ lb

A7. $W = VD$

$V = \text{Height} \times \text{Area}$

$V = \text{Height} \times \pi\text{Radius}^2$ or $\text{Height} \times \pi \times (1/2\ \text{Diameter})^2$

$V = (4\ ft) \times (\pi \times (1/2 \times 24\ ft)^2)$

$V = 1809.557\ ft^3$

$V = (1809.557\ ft^3) \times (7.481\ gal/ft^3)$

$V = 13{,}537.299\ gal$

$W = (13537.299\ gal) \times (8.354\ lb/gal)$

$W = 113{,}091\ lb$

A8. $D = W/V$

$V = (8.5\ in) \times (11\ in) \times (2\ in)$

$V = 187\ in^3$

$W = (5\ lb) \times (16\ oz/lb)$

$W = 80\ oz$

$D = (80\ oz)/(187\ in^3)$

$D = 0.4\ oz/in^3$

A9. $V = W/D$

$V = (453.6\ g)/0.0025\ g/cm^3)$

$V = 181{,}440\ cm^3$

$V = (181{,}440\ cm^3)(1/28{,}317\ ft3/cm^3)$

$V = 6.4\ ft^3$

A10. Weight:

Concrete mix: 80 lb (given)

Water:

(4 L) x (1000 g/L) x (1/453.6 lb/g) = 8.82 lb

Total:

80 lb + 8.82 lb = 88.82 lb

Volume:

Concrete mix: 0.53 ft^3 (given)

Water:

(4 L) x (0.03531 ft^3/L) = 0.14 ft^3

Total:

0.53 ft^3 + 0.14 ft^3 = 0.67 ft^3

Density:

D = W/V

D = 88.82 lb/0.67 ft^3

D = 132.57 lb/ft^3

S5 FLO SCI ENG Formats

Numbers can be expressed in three different formats.

FLO or Floating Point is the format you are familiar with. 64327.59 is an example.

Of course you know this is the same as:

$6x10^4+4x10^3+3x10^2+2x10^1+7x10^0+5x10^{-1}+9x10^{-2}$

And, $10^0 = 1$, $10^{-n} = 1/10^n$

Now we can also express this number is what is called SCI or scientific format

$64327.59 = 6.432759 \times 10^4$

Or in ENG or engineering format

$64327.59 = 64.32759 \times 10^3$

In the ENG format you will always have 10 to an exponent that is a multiple of 3. You'll see why this is when we study Prefixes in another lesson/

SCI and ENG notations are sometimes used in documentation and you can always convert from one to the other with our calculator or to FLO if the number is not too large.

However, for very large or very small numbers SCI or ENG formats are necessary.

Frankly, if you are going to be working with very large or very small numbers you will probably be using a computer and much more powerful tools than a calculator.

It is easy to use scientific notation with a tool like Wolfram Alpha.

However, you may occasionally see them with the calculator if you multiply or divide large numbers or use the y^x key with large exponents.

$12^{21} = 4.6 \times 10^{22}$

Now multiply by 9^{13}

$1.169 \times 10^{35} = 1.169388422 \times 10^{35}$

Also, the largest exponent of 10 the calculator will accept is 99.

109^85   error

But, WA handles it just fine.

S5 FLO SCI ENG Formats Exercises

Using your calculator, convert the following numbers to both SCI and ENG.

Q1. 640873.26

Q2. 2347168.002

Q3. 0.0002547

Using your calculator, convert the following numbers to both SCI and ENG, fixing each to the number digits past the decimal point as indicated.

Q4. 54178962.3 (3 digits past the decimal point)

Q5. 214697.0045 (2 digits past the decimal point)

Q6. 145879125 (4 digits past the decimal point)

Using your calculator, calculate the following numbers. If you receive an error message, use Wolfram Alpha.

Q7. $15^{26}x22^{3}$ =

Q8. $26^{56}x32^{54}$ =

Q9. $45^{-23}x16^{-13}$ =

Q10. $18.45^{-56}x46.78^{-24}$ =

A1. SCI = 6.4087326×10^5; ENG = 640.87326×10^3

A2. SCI = 2.347168002×10^6; ENG = 2.347168002×10^6

A3. SCI = 2.547×10^{-4}; ENG = 254.7×10^{-6}

A4. SCI = 5.418×10^7; ENG = 54.179×10^6

A5. SCI = 2.15×10^5; ENG = 214.70×10^3

A6. SCI = 1.4588×10^8; ENG = 145.8791×10^6

A7. 4.0331166×10^{34}

A8. Error

WA 26^56x32^54

$3.28553665 \times 10^{160}$

A9. $2.101611366 \times 10^{-54}$

A10. Interestingly, the calculator says “0” instead of “Error”

WA 18.45^-56x46.78^-24

$1.053799609 \times 10^{-111}$

S5A FLO SCI ENG Formats Addendum

As we learned in S5, numbers can be expressed in three different formats.

FLO or Floating Point is the format you are familiar with. 64327.59 is an example.

SCI or scientific format

$64327.59 = 6.432759 \times 10^4$

ENG or engineering format

$64327.59 = 64.32759 \times 10^3$

What we haven't learned yet is how to enter a number in a SCI or ENG format into the calculator.

It is very easy. You just use the EE Key.

To enter 6.432759×10^4

Just enter 6.432759 and Press the EE key,

Then enter 4, and you are done.

Now you can change it into any other format, and also you can save it in memory and the recall it in this format.

Similar for ENG format

Just enter 64.32759 and Press EE, and then enter 3

You can also enter negative numbers.

Just press the + <-> - key before you press the EE Key.

6.432759 + <-> - EE 3

Enters the negative of this number

You can also enter a negative exponent by just pressing the + <-> - key before entering he exponent

6.432 EE + <-> - 4

Enters $6.432x10^{-4}$ or .00006432

Of course, you could also enter

$-6.432x10^{-5}$ or -.00006432

6.432 + <-> - EE 5 + <-> -

S6 Prefixes

In science and engineering Prefixes are used to change the size of units.

For example, Kilometer, km, means 1,000 Meters

So, 1 km = 1,000m = 10^{3} m

1 centimeter = .01m = (1/100)m = 10^{-2}m = 1cm

1 decimeter = .1m = (1/10)m = 10^{-1}m = 1dm

1 millimeter = .001m = (1/1000)m = 10^{-3}m = 1mm

The most common Metric Prefixes are listed below along with their exponents of 10.

milli (m)	-3	Kilo (K)	+3	Thousand
micro(µ)	-6	Mega(M)	+6	Million
nano (n)	-9	Giga (G)	+9	Billion
pico (p)	-12	Tera (T)	+12	Trillion

Examples: 27 nS = 27×10^{-9} S = .000000027 S

27 µS = 27×10^{-6} S = .000027 S

45 GH = 45×10^{9} H = 45000000000 H

78KB = 78×10^{3}B = 78000B

3.5KΩ = 3500Ω

Now the laws or rules of exponents are:

$10^n \times 10^m = 10^{n+m}$ for any exponents n and m

Also, $10^0 = 1$ and $10^{-n} = 1/10^n$

So suppose we have, for example

$7mA x 8M\Omega = 7x10^{-3}Ax8x10^{6}\Omega = 56x10^{3}V = 56KV$

Since, $1Ax1\Omega = 1V$ [This is Ohm's Law]

Thus, we see mxM = K since $10^{-3}x10^{6} = 10^{3}$

So we multiply, x, two prefixes to get one prefix by simply adding the exponents.

mxG = M since -3 + 9 = 6

mxm = μ since -3+ -3 = -6

nxK = μ since -9 + 3 = -6

If you are going to become an electrician or electronics technician you should learn this prefix table, and practice multiplying prefixes.

Then, you will use this along with the Technician's Triangle we will discuss in another lesson.

This will greatly simplify calculations you will be making when you troubleshoot electrical or electronic systems or equipment.

In the Metric system we use powers of 10

In the Digital system we use powers of 2.

Note: $2^{10} = 1024 \approx 1000 = 10^3$

The most common Digital Prefixes are listed below along with their exponents of 2.

milli (m)	-10	Kilo (K)	+10
micro(µ)	-20	Mega(M)	+20
nano (n)	-30	Giga (G)	+30
pico (p)	-40	Tera (T)	+40

If you are going to become a computer or communications technician, you will want to master this system as well. It works just like the metric system.

For example, mSxMH = KC since 1Sx1H = 1C

Because -10 + 20 = +10

The purpose of this Lesson is to make you aware of these Prefixes. You will want to master them IF you decide to learn a technical field where they are used a lot.

Prefix Product Table

		0	+3	+6	+9	+12
X		1	K	M	G	T
0	1	1	K	M	G	T
-3	m	m	1	K	M	G
-6	µ	µ	m	1	K	M
-9	n	n	µ	m	1	K
-12	p	p	n	µ	m	1

We will make use of this when we discuss the Technician's Triangle

Of course, this Table can be expanded, but this is what one usually uses.

For example, mxn = p

But, µxn = f

where femto stands for 10^{-15}

Some Musings.

Most of us don’t really appreciate the difference between a million and a billion

How long is one million seconds, 1 MS ?

11.57 days 1,000,000 / 60 / 60 / 24

How long is one billion seconds, 1GS ?

32 years

11,570 / 365

How long is one trillion seconds, 1 TS ?

32,000 years.

Apply similar questions about our national debt and our money supply.

One million pennies is ten thousand dollars

One billion pennies is ten million dollars.

The DNA in one human cell is about 6 ft long if it unwound. Of course, it is very thin. Similar to extending your little finger from LA to Paris.

There are about one trillion cells in your body. So how long would your DNA be if it was all strung out end to end? How about a billion miles?

S6 Prefixes Exercises

Q1. Using the generic unit of measure, S, and the **metric** prefixes, calculate the new prefix for the following problems.

a. mS x nS
b. mS x MS
c. KS x MS
d. µS x µS
e. nS x GS
f. TS x µS
g. GS x KS
h. mS x µS
i. GS x pS
j. TS x µS

Q2. Using the generic unit of measure, S, and the **metric** prefixes, convert the following to numbers.

a. 15 nS
b. 23 KS
c. 47 TS
d. 28 µS
e. 84 GS
f. 18 MS
g. 43 pS
h. 98 mS
i. 4.2 mS
j. 3.84 GS

Q3. Using the generic unit of measure, S, and the **digital** prefixes, calculate the new prefix for the following problems.

a. mS x nS
b. mS x MS
c. KS x MS
d. µS x µS
e. nS x GS
f. TS x µS
g. GS x KS
h. mS x µS
i. GS x pS
j. TS x µS

Q4. Using the generic unit of measure, S, and the **digital** prefixes, convert the following to numbers.

a. 15 nS
b. 23 KS
c. 47 TS
d. 28 µS
e. 84 GS
f. 18 MS
g. 43 pS
h. 98 mS
i. 4.2 mS
j. 3.84 GS

A1.

a. mS x nS = 10^{-3}S x 10^{-9}S = 10^{-12}S = pS
b. mS x MS = 10^{-3}S x 10^{6}S = 10^{3}S = KS
c. KS x MS = 10^{3}S x 10^{6}S = 10^{9}S = GS
d. µS x µS = 10^{-6}S x 10^{-6}S = 10^{-12}S = pS
e. nS x GS = 10^{-9}S x 10^{9}S = 10^{0}S = S
f. TS x µS = 10^{12}S x 10^{-6}S = 10^{6}S = MS
g. GS x KS = 10^{9}S x 10^{3}S = 10^{12}S = TS
h. mS x µS = 10^{-3}S x 10^{-6}S = 10^{-9}S = nS
i. GS x pS = 10^{9}S x 10^{-12}S = 10^{-3}S = mS
j. TS x µS = 10^{12}S x 10^{-6}S = 10^{6}S = MS

A2.

a. 15 nS = $15x10^{-9}$ S = 0.000000015 S
b. 23 KS = $23x10^{3}$ S = 23,000 S
c. 47 TS = $47x10^{12}$ S = 47,000,000,000,000 S
d. 28 µS = $28x10^{-6}$ S = 0.000028 S
e. 84 GS = $84x10^{9}$ S = 84,000,000,000 S
f. 18 MS = $18x10^{6}$ S = 18,000,000 S
g. 43 pS = $43x10^{-12}$ S = 0.000000000043 S
h. 98 mS = $98x10^{-3}$ = 0.098 S
i. 4.2 mS = $4.2x10^{-3}$ = 0.0042 S
j. 3.84 GS = $3.84x10^{9}$ S = 3,840,000,000 S

A3.

a. mS x nS = 2^{-10}S x 2^{-30}S = 2^{-40}S = pS
b. mS x MS = 2^{-10}S x 2^{20}S = 2^{10}S = KS
c. KS x MS = 2^{10}S x 2^{20}S = 2^{30}S = GS
d. µS x µS = 2^{-20}S x 2^{-20}S = 2^{-40}S = pS
e. nS x GS = 2^{-30}S x 2^{30}S = 2^{0}S = S
f. TS x µS = 2^{40}S x 2^{-20}S = 2^{20}S = MS
g. GS x KS = 2^{30}S x 2^{10}S = 2^{40}S = TS

h. mS x µS = 2^{-10}S x 2^{-20}S = 2^{-30}S = nS

i. GS x pS = 2^{30}S x 2^{-40}S = 2^{-10}S = mS

j. TS x µS = 2^{40}S x 2^{-20}S = 2^{20}S = MS

A4.

a. 15 nS = 15x2^{-30} S = 0.000000014 S

b. 23 KS = 23x2^{10} S = 23,552 S

c. 47 TS = 47x2^{40} S = 5.167704651x10^{13} S

d. 28 µS = 28x2^{-20} S = 0.000026703 S

e. 84 GS = 84x2^{30} S = 8,589,934,592 S

f. 18 MS = 18x2^{20} S = 18,874,368 S

g. 43 pS = 43x2^{-40} S = 3.910827218x10^{-11} S

h. 98 mS = 98x2^{-10} = 0.095703125 S

i. 4.2 mS = 4.2x2^{-10} = 0.004101562 S

j. 3.84 GS = 3.84x2^{30} S = 34,123,168,604 S

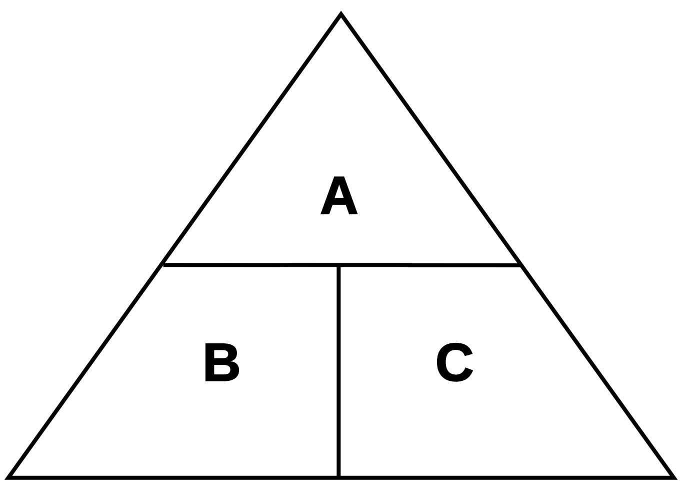
S7 Technician's Triangle

Often one is faced with an equation A = BxC, where one must solve for one of these variables when the other two are known.

This yields three equations as you have learned.

A = BxC   B = A / C   C = A / B

Sometimes it is easiest to simply put this into what I call a Technician's Triangle. Then, one can "solve" the equation very easily.



Now to "solve" for any variable, just perform the calculation with the other two variables.

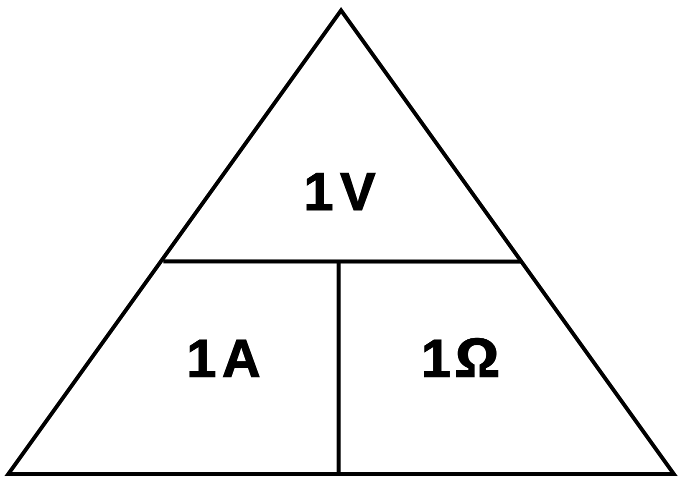
A = BxC   B = A / C   C = A / B

Things get interesting when the units involved have prefixes attached.

Let’s look at an example from electronics.

Ohm’s Law is 1V = 1Ax1Ω

Where V is Volts, A is Amps, Ω is Resistance



But, often one has to deal with prefixes attached to these units. For example, we might have

5μA x 7KΩ = .000005x7000 V = .035 V = 35 mV

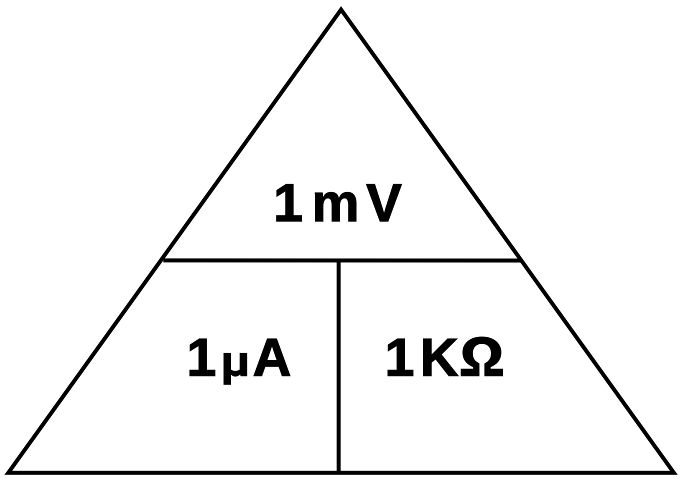
This is the way it has been dealt with classically.

There must be an easier way!

Well, there is.

We learned in the Prefixes lesson that

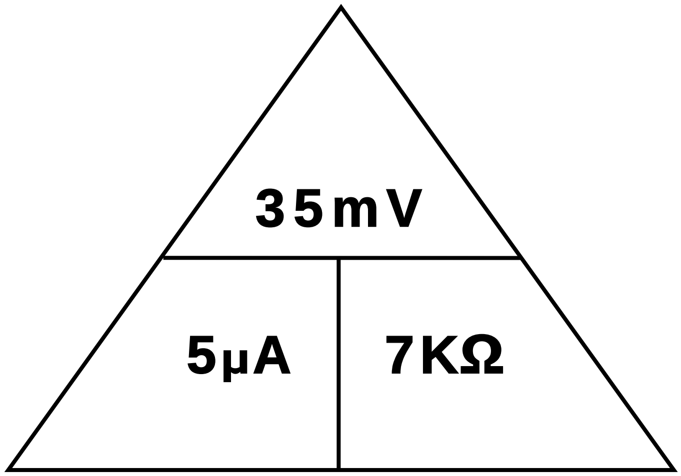
μ x K = m



This then leads us to the following Tech Triangle

Remember we know μ x K = m

So, this then leads us to the following Tech Triangle



So, all we have to do to solve for any one of these given the other two is simply do the simple arithmetic.

This is much easier than the old fashioned way.

5μAx7KΩ = .000005x7000V = .035V= 35mV

Or 35mV/7KΩ = .035/7000 A = .000005 A = 5μA

Or 35mV/5μA = .035/.000005 Ω = 7000Ω = 7 KΩ

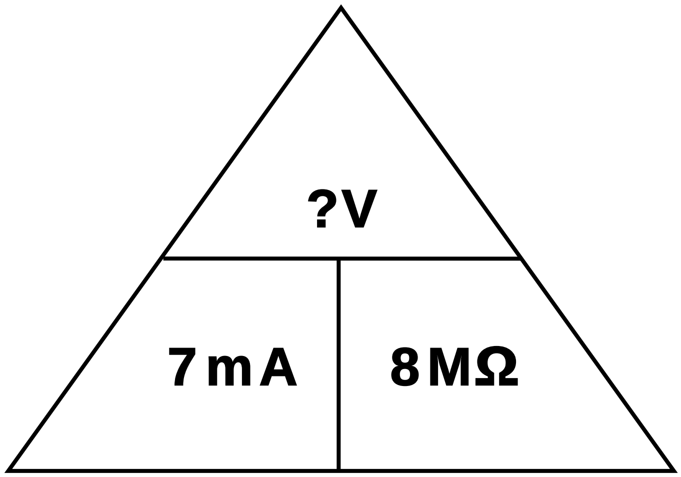
It was amazing how many times engineers and technicians got the decimal place wrong and were off by an order of magnitude, i.e. 10x

So, quick now, what is 7 mA times 8 MΩ ?

So, quick now, what is 7 mA times 8 MΩ ?

Remember we know m x M = K

So, this then leads us to the following Tech Triangle



Answer: 56 KV

This is much easier than the old fashioned way.

So, quick now, what is 7 mA times 8 MΩ ?

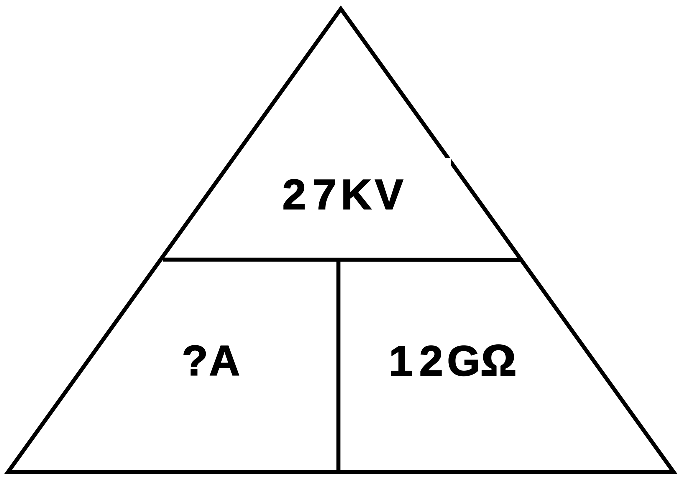
Try it the old fashioned way, if you want to experience what some of our ancestors went through. Even with slide rules and log tables it was more difficult than with a calculator. But, it is even easy to make a mistake with a calculator doing it the old fashioned way.

Try 2.4mA x 6.7 MΩ Use the TT, mxM = K

Answer: 2.4x6.7 KV = 16 KV

OK one more, quick. 27KV across a 12GΩ resistor yields how many amps, A?

So, this then leads us to the following Tech Triangle



Well look in the Prefix Table.

What times G yields K? Answer: μ

[G is +9 and K is +3, So we need a -6 since

9+(-6)= +3, So, we need a μ and Gxμ = K]

So, the answer is 27/12 μA = 2.25 μA

This is much easier than the old fashioned way.

Try it the old fashioned way, if you want to experience what some of our ancestors went through. They didn't even have calculators. But, our calculator won't even take this many 0's in FLO so you would have to use SCI format.

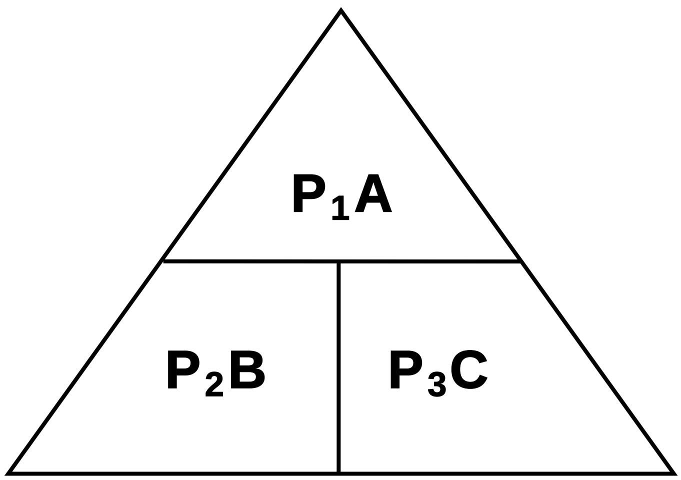
27000/12000000000 = .00000225

There are many fields where you have an equation like   1A = 1Bx1C where A,B,C are some units.

Then, a Technician's Triangle will apply.

You will need to learn the Prefixes and remember to multiply two prefixes you just add their exponents of their power of 10, or of their power of 2 in the digital case.

Then the calculations will be easy to perform.



Where $P_1 = P_2 x P_3$, from the Table of Prefixes

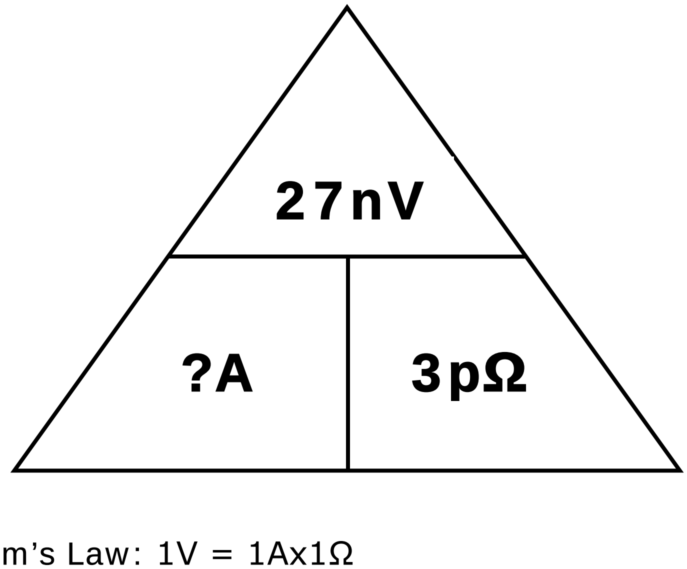
This is much easier than the old fashioned way.

Simply practice in whatever technical field you are in with the relevant equations.

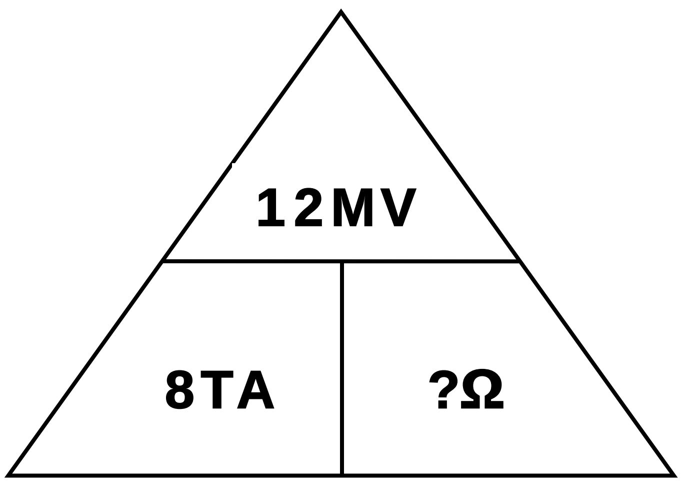
S7 Technician's Triangle Exercises

Solve for the unknown using metric prefixes.

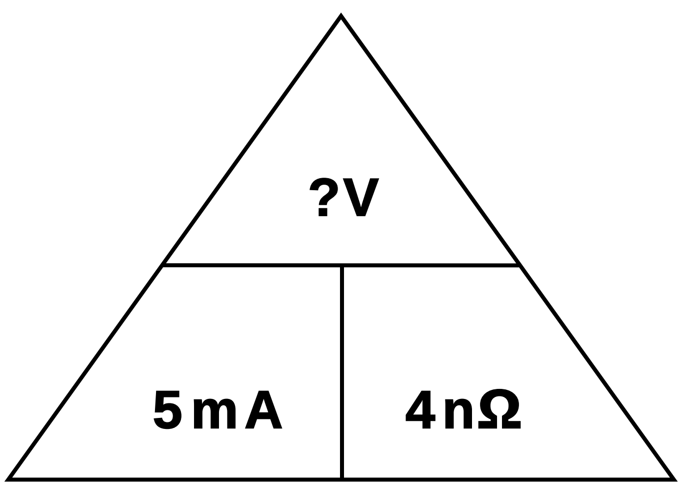
Q1. Ohm's Law: 1V = 1Ax1Ω



Q2. Ohm's Law: 1V = 1Ax1Ω

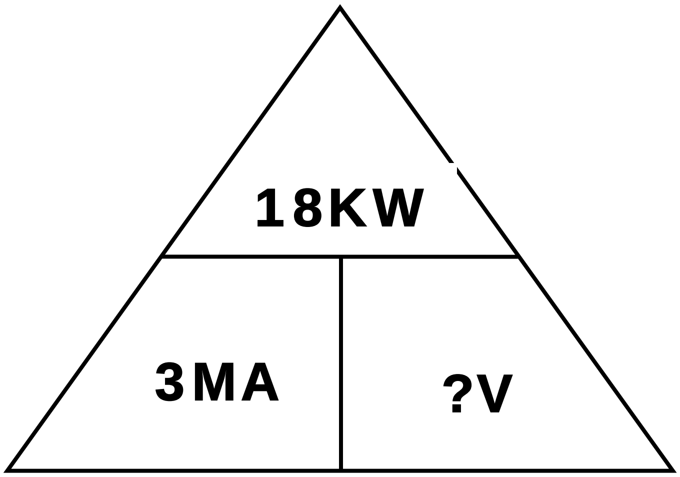


Q3. Ohm's Law: 1V = 1Ax1Ω

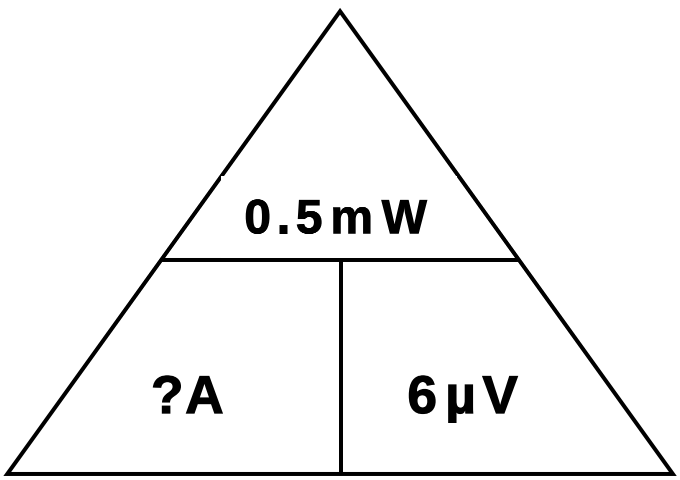


Q4. P = I x V (power = current x volts)

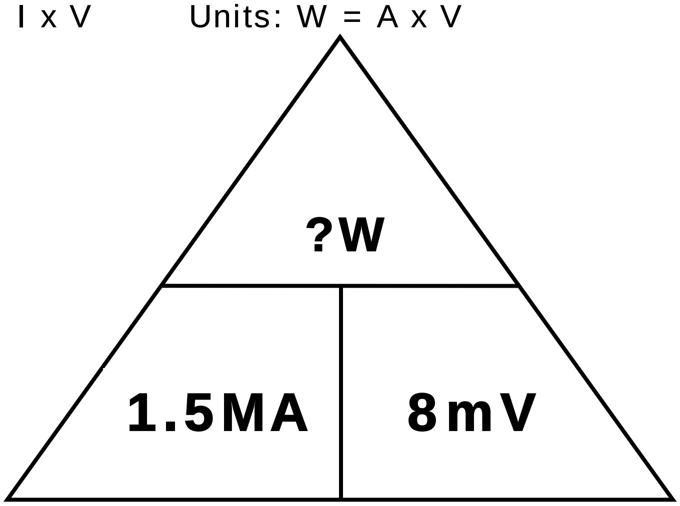
Units: W = A x V (watts = amps x volts)



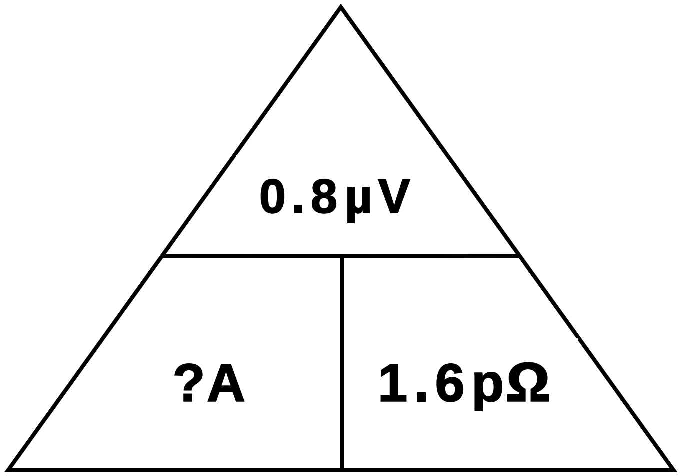
Q5. P = I x V Units: W = A x V



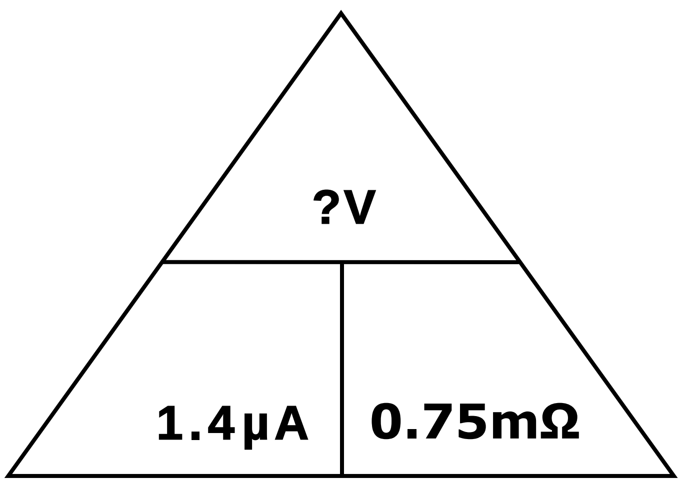
Q6. P = I x V Units: W = A x V



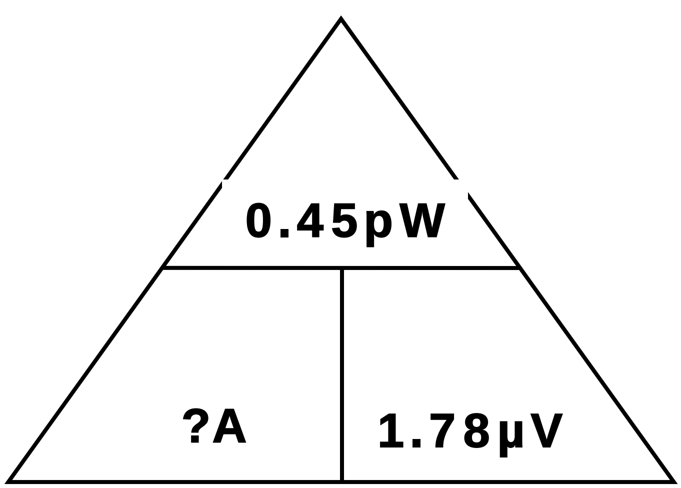
Q7. Ohm's Law: 1V = 1Ax1Ω



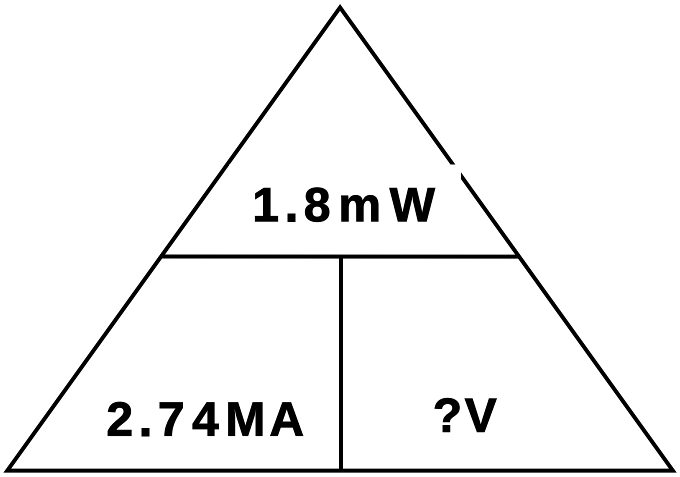
Q8. Ohm's Law: 1V = 1Ax1Ω



Q9. P = I x V   Units: W = A x V



Q10. P = I x V   Units: W = A x V



A1. 27nV = ?A x 3pΩ

n = ? + p --> -9 = ? + -12 --> ? = +3 --> K

27nV = ?KA x 3pΩ

27 = ? x 3 -> ? = 9

Unknown: 9KA

27nV = 9KA x 3pΩ

A2. 12MV = 8TA x ?Ω

M = T + ? --> +6 = +12 + ? --> ? = -6 --> µ

12MV = 8TA x ?µΩ

12 = 8 x ? -> ? = 1.5

Unknown: 1.5µΩ

12MV = 8TA x 1.5µΩ

A3. ?V = 5mA x 4nΩ

? = m + n --> ? = (-3) + (-9) --> ? = -12 --> p

?pV = 5mA x 4nΩ

? = 5 x 4 -> ? = 20

Unknown: 20pV

20pV = 5mA x 4nΩ

A4. 18KW = 3MA x ?V

K = M + ? --> +3 = +6 + ? --> ? = -3 --> m

18KW = 3MA x ?mV

18 = 3 x ? -> ? = 6

Unknown: 6mV

18KW = 3MA x 6mV

A5. 0.5mW = ?A x 6µV

m = ? + µ --> -3 = ? + (-6) --> = +3 --> K

0.5mW = ?KA x 6µV

0.5 = ? x 6 -> ? = 1/12 or 0.083

Unknown: 0.083KA

0.5mW = 0.083KA x 6µV

A6. ?W = 1.5MA x 8mV

? = M + m --> ? = +6 + (-3) --> = +3 --> K

?KW = 1.5MA x 8mV

? = 1.5 x 8 -> ? = 12

Unknown: 12KW

12KW = 1.5MA x 8mV

A7. 0.8µV = ?A x 1.6pΩ

µ = ? + p --> -6 = ? + (-9) --> ? = +3 --> K

0.8µV = ?KA x 1.6pΩ

0.8 = ? x 1.6 -> ? = 0.5

Unknown: 0.5KA

0.8µV = 0.5KA x 1.6pΩ

A8. ?V = 1.4µA x 0.75mΩ

?= µ + m --> ? = (-6) + (-3) --> ? = -9 --> n

?nV = 1.4µA x 0.75mΩ

? = 1.4 x 0.75 -> ? = 1.05

Unknown: 1.05nV

1.05nV = 1.4µA x 0.75mΩ

A9. 0.45pW = ?A x 1.78µV

p = ? + µ --> -12 = -6 + ? --> = -6 --> µ

0.45pW = ?µA x 1.78µV

0.45 = ? x 1.78 -> ? = 0.253

Unknown: 0.253µA

0.45pW = 0.253µA x 1.78µV

A10. 1.8mW = 2.74MA x ?V

m = M + ? --> -3 = +6 + ? --> = -9 --> n

1.8mW = 2.74MA x ?nV

1.8 = 2.74 x ? -> ? = 0.657

Unknown: 0.657nV

1.8mW = 2.74MA x 0.657nV

S8 Polar Rectangular Coordinates

In the plane, there are two ways to specify a point.

Rectangular Coordinates (x,y)

Polar Coordinates (r, θ) where

$r = (x^2 + y^2)^{1/2}$,

$\theta = \tan^{-1}(y/x)$ in Quadrants 1 and 4

and $\theta = \tan^{-1}(y/x) + 180^o$ in Quads 2 and 3

Example 1: $(4,3) = (5, 36.87^o)$ since

$\tan^{-1}(3/4) = 36.87^o$ and $5 = (4^2 + 3^2)^{1/2}$

Example 2: $(-4,3) = (5, 143.13^o)$ since

$\tan^{-1}(-3/4) = -36.87^o + 180^o = 143.13^o$

Fortunately, the TI30Xa will do this automatically with the R → P and P → R Keys.

2nd . 2 This fixes the display to two digits past .

Function	Key	Enter	Display
	4	4	
x <--> y	2nd π		0.00
	3	3	
R< - ->P	2nd -		5.00
x <--> y	2nd π		36.87

Function	Key	Enter	Display
	4	4	
+< -->-		-4	
x <--> y	2nd π		0.00
	3	3	
R< - ->P	2nd -		5.00
x <--> y	2nd π		143.13

You can go from P to R also.

Function	Key	Enter	Display
		5	5
x <--> y	2^{nd} π		0.00
		143.13	143.13
P< - ->R	2^{nd} x		-3.9999
x <--> y	2^{nd} π		3.00

Note: All of this works if you use RAD or GRAD for the degrees, for those of you who are more advanced in trigonometry.

Now just do some Exercises

$(4, 9) = (9.85, 66.03^{o})$ R to P

$(7, 197^{o}) = (-6.69, -2.05)$ P to R

S8 Polar Rectangular Coordinates Exercises

For the following exercises, graph the rectangular coordinates to determine quadrant, then solve for the polar coordinates.

Q1. (5, 12)

Q2. (8, 15)

Q3. (-8, -15)

Q4. (-4.5, 6.3)

Q5. (3.7, -8.2)

Q6. (-8.9, -12.5)

For the following exercises, solve for the rectangular coordinates.

Q7. (9, 45°)

Q8. (6, 32°)

Q9. (12, 127°)

Q10. (4.7, 118.6°)

Q11. (5.6, 210°)

Q12. (7.8, 301.9°)

Using the R to P button on your calculator, convert these rectangular coordinates to polar coordinates.

Q13. (5, 7)

Q14. (8, 13)

Q15. (-7, 16)

Q16. (6.3, -8.2)

Using the P to R button on your calculator, convert these rectangular coordinates to polar coordinates.

Q17. (9, 27°)

Q18. (10, 75°)

Q19. (4.7, 190.5°)

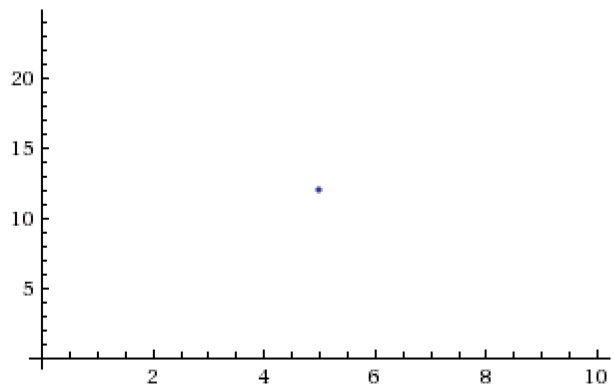
Q20. (13.45, 347°)

A1. $r = (x^2 + y^2)^{1/2}$

$r = (5^2 + 12^2)^{1/2}$

$r = 13$

Plot:



Quadrant 1

$\Theta = \tan^{-1}(y/x)$

$\Theta = \tan^{-1}(12/5)$

$\Theta = 67.38°$

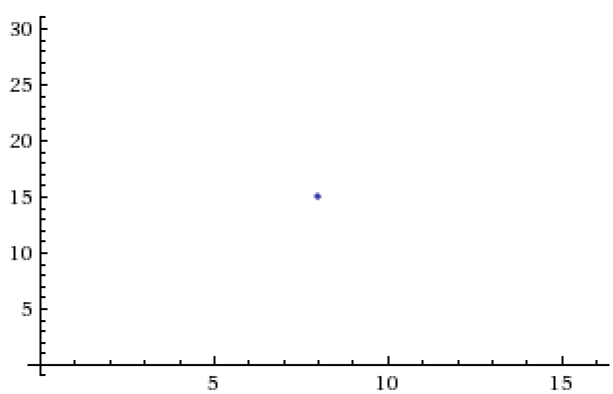
$(13, 67.38°)$

A2. $r = (x^2 + y^2)^{1/2}$

$r = (8^2 + 15^2)^{1/2}$

$r = 17$

Plot:



Quadrant 1

$\Theta = \tan^{-1}(y/x)$

$\Theta = \tan^{-1}(15/8)$

$\Theta = 61.93°$

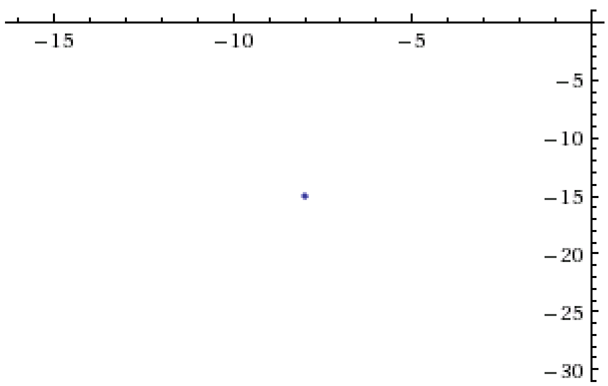
(17, 61.93°)

A3. $r = (x^2 + y^2)^{1/2}$

$r = ((-8)^2 + (-15)^2)^{1/2}$

$r = 17$

Plot:



Quadrant 3

$\Theta = \tan^{-1}(y/x) + 180°$

$\Theta = \tan^{-1}(-15/-8) + 180°$

$\Theta = 241.93°$

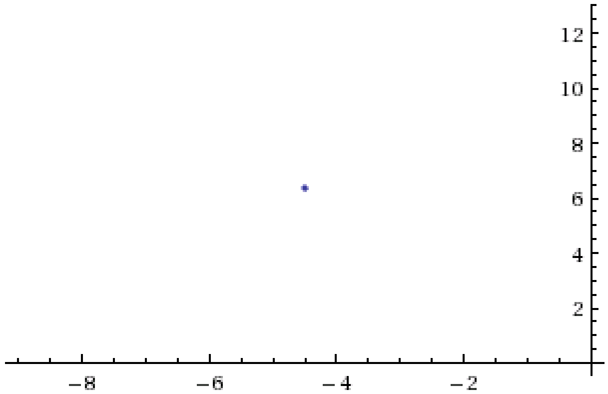
(17, 241.93°)

A4. $r = (x^2 + y^2)^{1/2}$

$r = ((-4.5)^2 + 6.3^2)^{1/2}$

$r = 7.74$

Plot:



Quadrant 2

$\Theta = \tan^{-1}(y/x) + 180°$

$\Theta = \tan^{-1}(-4.5/6.3) + 180°$

$\Theta = 144.46°$

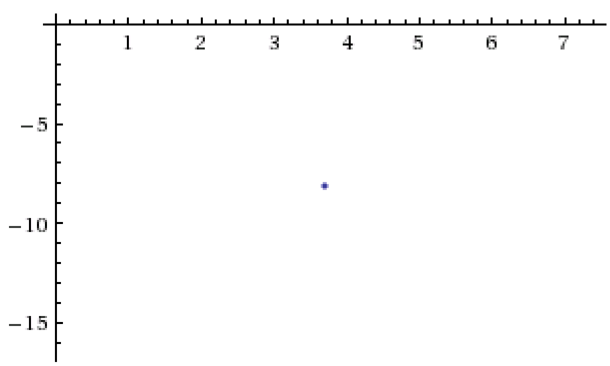
(7.74, 144.46°)

A5. $r = (x^2 + y^2)^{1/2}$

$r = (3.7^2 + (-8.2)^2)^{1/2}$

$r = 9.00$

Plot:



Quadrant 4

$\Theta = \tan^{-1}(y/x)$

$\Theta = \tan^{-1}(3.7/-8.2)$

$\Theta = -24.29° = -24.29° + 360° = 335.71°$

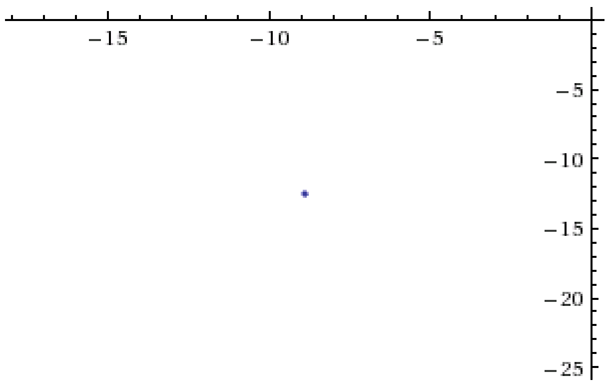
(9.00, -24.29°) or (9.00, 335.71°)

A6. $r = (x^2 + y^2)^{1/2}$

$r = ((-8.9)^2 + (-12.5)^2)^{1/2}$

r = 15.35

Plot:



Quadrant 3

$\Theta = \tan^{-1}(y/x) + 180°$

$\Theta = \tan^{-1}(-8.9/-12.5) + 180°$

Θ = 215.45°

(15.35, 215.45°)

A7. x = rcos(Θ)

x = 9cos(45°)

x = 6.36

y = rsin(Θ)

y = 9sin(45°)

y = 6.36

(6.36, 6.36)

A8. x = rcos(Θ)

x = 6cos(32°)

x = 5.09

y = rsin(Θ)

y = 6sin(32°)

y = 3.18

(5.09, 3.18)

A9. x = rcos(Θ)

x = 12cos(127°)

x = -7.22

y = rsin(Θ)

y = 12sin(127°)

y = 9.58

(-7.22, 9.58)

A10. x = rcos(Θ)

x = 4.7cos(118.6°)

x = -2.25

y = rsin(Θ)

y = 4.7sin(118.6°)

y = 4.13

(-2.25, 4.13)

A11. x = rcos(Θ)

x = 5.6cos(210°)

x = -4.8

y = rsin(Θ)

y = 5.6sin(210°)

y = -2.8

(-4.8, -2.8)

A12. x = rcos(Θ)

x = 7.8cos(301.9°)

x = 4.12

$y = r\sin(\Theta)$

$y = 7.8\sin(301.9°)$

$y = -6.62$

(4.12, -6.62)

A13. (8.60, 54.46°)

A14. (15.26, 58.39°)

A15. (17.46, 113.63°)

A16. (10.34, -52.47°) or (10.34, 307.53°) -52.47° + 360° = 307.53°

A17. (8.02, 4.09)

A18. (2.59, 9.66)

A19. (-4.62, -0.86)

A20. (13.11, -3.03)

Note: (13.45, -13°) will get you the same answer because 347°-360°=-13°