Trade Skills for Success: Numeracy

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Pre-Apprenticeship Applied Learning Hands-On Course

Karynn A. Scott

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Contents

Territory Acknowldgement

Camosun College is located in beautiful Victoria, British Columbia with campuses on the Traditional Territories of the Lekwungen and WSÁNEĆ peoples. We acknowledge their welcome and graciousness to the students who seek knowledge here.

Introduction

Pre-Apprentice Applied Learning, Hands-on Course

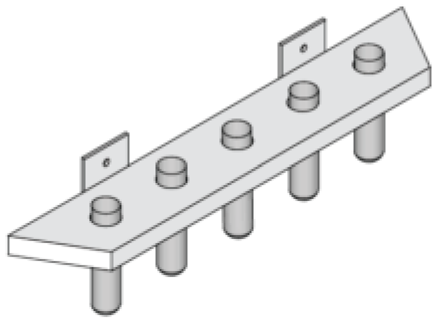
Numeracy is the ability to use and understand numbers. Mathematics is useful in everyday life, especially as a tradesperson. As an apprentice, you will be expected to know how to use certain measuring tools and understand how to measure certain materials.

Many of the **formulas, rules, and tools** in this book have cross-over from trade to trade. Fractions and decimals are used in measuring across all trades. Percentages, ratios, degrees…you name it, we use them all! The concepts we discuss do not apply to just one trade, but many. This book is designed to help you use your hands while you measure and calculate. Offering many examples, this book will help you learn **the basics of measuring and many measuring tools**.

You will also be given insight into the various professions that we discuss throughout this book. The skilled trades are **so** broad and span over many career directions. If you are considering entering the trades, **it is time to become familiar with Numeracy in the trades.** Numeracy is not something to be intimidated by, and it is also very practical. Relax and read through the information, explore with practice exercise questions, gain confidence and enjoy some hands-on activities.

Introduction to the Wall Hanging Project

Multi-Trade Hands-On Numeracy Activity



In multiple sections of this text, you will find instructions on how to build “The Wall Hanging Project.” This project is an introduction to many different trades, math problem-solving, the use of hands-on measuring tools, and a broader understanding of how to make something from start to finish. The intention of this project is to build a propagation station for halophyte plants. However, the same principles can be used for whatever you like: a pen holder, a tool holder… Let the creativity flow!

Here is where you will find instructions throughout this text:

- **Introduction:** Estimation.
- **Woodworking Trades:** Measure, mark and cut wood to length; fractions; read a tape measure; and measure twice, cut once.
- **Pipe Trades**: Measure and cut angles; and get to know the measuring tools for angles.
- **Metal Trades:** Read a blueprint; use hole layout tools; layout holes; drill holes; and work with decimals.
- **Culinary and Horticulture:** Make a 5% saline solution for Halophytes; work with percentages and ratios; understand scales; and measure dry, wet and solid ingredients.
- **Recap:** Hanging the shelf with a level

Wall Hanging Blueprint

Open and/or download a PDF version of the Wall Hanging Blueprint.

Wall Hanging Project Recommendations

- **Wood:** Cedar, cherry, pine, mahogany, plywood, oak
- **Vials:** 30 mm diameter, 80-120 ml, glass or plastic
- **Vial stopper/holder options:** 28-30 mm diameter gasket, electrical tape, elastic bands
- **Metal brackets:** $\frac{3}{32} - \frac{1}{8}$ thickness, carbon steel, stainless steel, copper
- **Drill bits for metal:** It is best to use a drill press but a hand-held drill is an option as well. Start with pilot holes and build up. Be sure to clamp your material.
- **Drill bits for wood:** Forstner drill bit – $1\frac{3}{8}$
- **Also:** Soil, water, halophytes, salt, & spray bottle – See Culinary and Horticulture Section

Safety

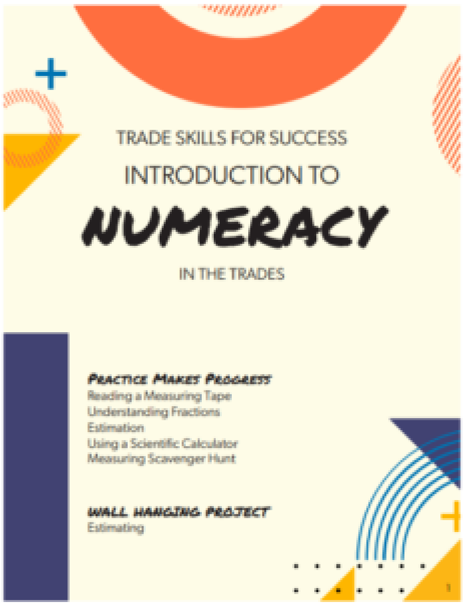
- Safety glasses on at all times
- Steel-toe boots on at all times
- Do not wear gloves while operating drill press
- Do not wear gloves while operating miter saw
- Be knowledgeable on proper operation of machines or ask for assistance and demonstrations
- Be aware of your neighbour

A professional tradesperson knows the importance of a tidy, safe workspace. Take pride in taking your time, doing things properly, and cleaning up behind yourself.

Teamwork makes the dream work. Is the person beside you struggling? Lend a hand! Are you done cleaning your area? Help out your neighbour! But most importantly, have fun together and be safe!

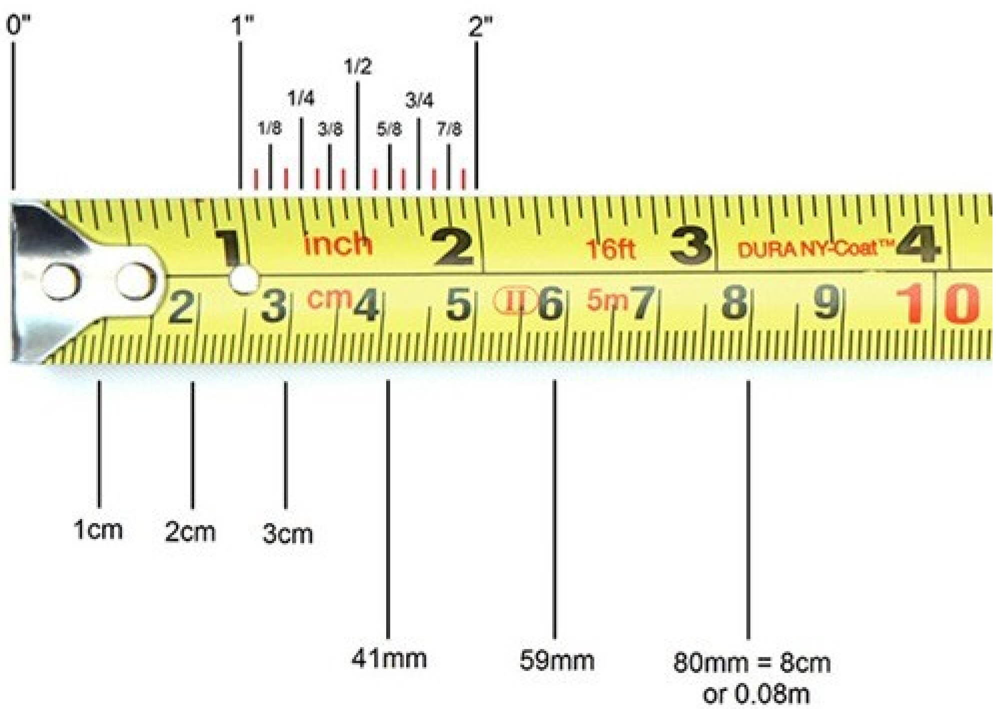
I

Introduction to Numeracy in the Trades

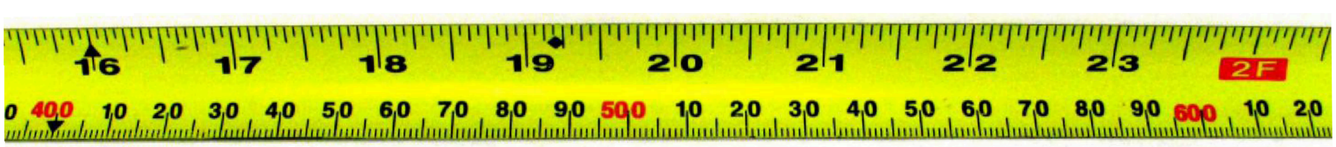


1.

Reading a Measuring Tape



1. Imperial units: The longest marks indicate inches. Use the next longest lines for ½ inches, the third longest for ¼ inches, and so on.
2. Metric units. The longest marks indicate centimetres. Use the smaller marks to find the length in millimeters.
3. Stretch your measuring tape across the object. Find the nearest full measurement and add the length from the smaller markings.



How to read the measuring tape

Imperial

12 inches is the same as 1 foot. The number indicating feet on the tape may be a different colour or be labeled with an “F” to mark the length. After each foot marking, the numbers next to each inch mark will either repeat from 1-11 again or keep counting to 13, 14, 15, and so on. Each tape measure varies so be sure to check yours.

Recognize the third longest line as ¼-inch increments. Find the ¼-inch marks centered between the ½-inch and full-inch lines.

Check the fourth longest lines to find -inch increments. Look for the shorter-inch markings centered between each of the ¼-inch lines.

Measure sixteenths of an inch with the smallest, densely-packed lines. If there are lines that are even shorter than the -inch markings, then each of them represents $\frac{1}{16}$-inch.

Reference to double arrows and diamonds for stud and truss spacing. 16 inches is the standard for wall studs. This will be marked with a set of 2 arrows. 19.2 inches is the standard for roof truss installation. This will be marked with a black diamond. If you’re not measuring for wall studs or roofing, don’t worry about any of these markings since you won’t need to use them.

Metric

Millimeters can be hard to read as they are the smallest, most densely-packed markings. Each millimeter represents $\frac{1}{10}$ of a centimeter or 0.1 centimeters. Each centimeter contains 10 millimeters. Metric tape measures rarely have units smaller than millimeters because it’s difficult to measure them precisely.

How to use the measuring tape

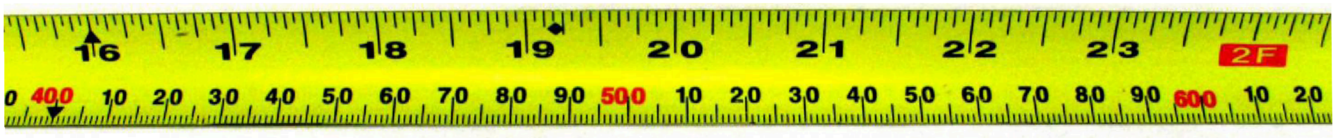
Place the tape’s hook at the end of the object you’re measuring. Hook the metal piece at the end of the measuring tape onto the edge of the object so it doesn’t slip. If you’re measuring the inside distance, such as the distance across a door frame or from one wall to another, push the metal hook flat against the surface instead. If the end of the tape measure has a hole, hook it onto a screw or nail to keep the end from moving.

> The hook is also known as “tang.” The metal hook is supposed to be a little loose. When latched onto an object, the hook pulls out so its width isn’t included in the measurement. When pushed up against the object on an inside measurement, the hook pushes flush against the tape so its width doesn’t affect

the measurement.

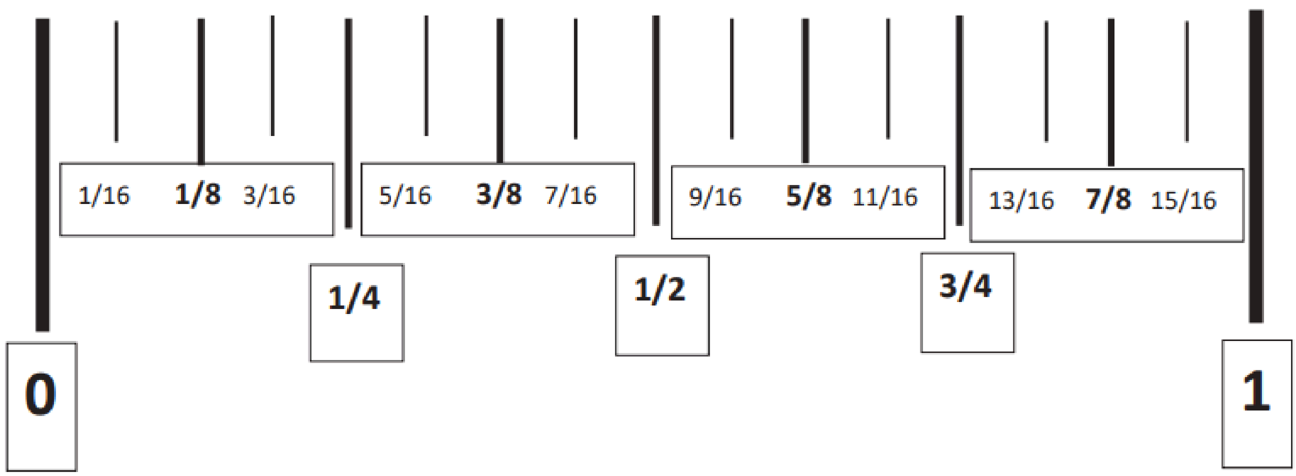
Try to keep the tape as straight as possible since letting it sag can skew the measurement.

Use the lock switch to keep the tape at the same length. If you need to compare or transfer your measurement, slide the lock switch forward to keep the tape from retracting.



2.

Measuring Systems



Measurement systems

The construction industry in Canada uses both the metric and the imperial systems of measurement. The architect's or engineer's plans and specifications dictate which system the tradesperson must use; therefore they must carry measuring tools for both systems.

Imperial system

The imperial system uses feet and inches and fractions of an inch. There are 12 inches to a foot and inches are divided into halves, quarters, eighths, and sixteenths.

Metric system

The base unit of length in the metric system is the meter. The meter is divided into 1000 units (millimeters). Measuring tapes are usually marked off in 10 millimeter units (centimeters). One hundred centimeters equals one meter.

Conversion Between Imperial and Metric

- 25.4 mm is equal to 1 inch

- 304.8 mm equals 1 foot

Convert Inches to Millimeters

Inches	Millimeters	Actual (mm)
1 / 16	2	3.59
1 / 8	3	3.18
3 / 16	5	4.76
1 / 4	6	6.35
5 / 16	8	7.94
3 / 8	10	9.53
7 / 16	11	11.11
1 / 2	13	12.7
9 / 16	14	14.29
5 / 8	16	15.88
11 / 16	17	17.46
3 / 4	19	19.05
13 / 16	21	20.64
7 / 8	22	22.23
15/16	24	23.81
1	25	25.40

3.

Estimation

Estimation is a useful tool in mathematical problem-solving. Estimating gives you an approximate or "ballpark" answer. It is important to be able to make estimates in your head before you use a calculator, to enable you to double- check your answer in case you press the wrong key on the calculator. People often estimate differently; there is no one correct way to estimate. It takes practice to get good at choosing numbers that make estimating easier.

Here are some estimating strategies:

1. Round to numbers that are easy for you to compute.

For example, about how much is 29 × 14? Some possible estimates are:

- 25 × 16 = 400
- 30 × 10 = 300
- 30 × 15 = 450

2. Use numbers that make sense to you

When you round, sometimes the result will be an underestimate (less than the exact answer), and sometimes it will be an overestimate (more than the exact answer).

Estimate these problems:

$$\begin{array}{lll} 31 \times 4 & 30 \times 4 = 120 & \text{a little more than } 120 \\ 48 \times 5 & 50 \times 5 = 250 & \text{a little less than } 250 \\ 17 \times 21.2 & 20 \times 20 = 400 & \text{about } 400 \end{array}$$

3. Choose numbers that are compatible and easy to work with for the problem.

For example, how much is 2775 divided by 6? Some possible estimates are:

3000 ÷ 6 = 500

4.

Using a Scientific Calculator

The calculator is an excellent tool for saving time and performing more complex calculations.

Modern scientific calculators generally have many more features than a standard four or five function calculator, and the feature set differs among manufacturers and models. It is therefore important that you check the instruction manual for your calculator to learn to use it properly.

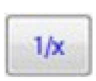
Some of the features of a scientific calculator that you will be using in the more advanced learning tasks include:

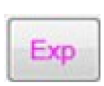
- scientific notation
- floating point arithmetic
- trigonometric functions
- exponential functions and roots beyond the square root
- quick access to constants such as π (pi) and e (natural log).

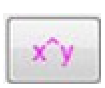
A scientific calculator can calculate angles using **sine, cosine, and tangent**.

Most scientific calculators also have keys for:

- 

% key: divides the number by 100
- 

Reciprocal Key (1/x or x-1): puts 1 as the numerator and the number you key in as the denominator and divides to get a decimal.
- 

Exponent Key: puts x10 on the display so that you can key in the exponent for Scientific Notation.
- 

Power Key: multiply a number by itself for the number of times you key in. All you have to do is enter y. It can also be used to find roots by letting y equal a fraction.

- 

Square Key: may also have Square Root on same key with one being a second function.

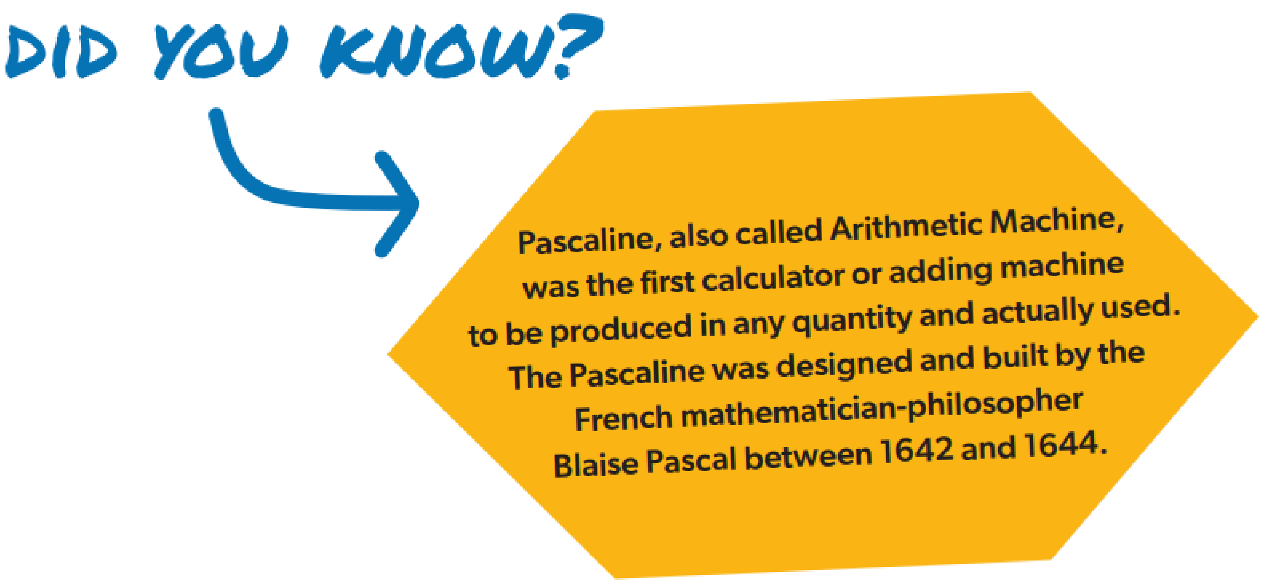
If your calculator has a fraction function, you can do this problem:

$$\frac{5}{12}+\frac{1}{12}$$

1. Press the 5 then $a^{b/c}$ then 1 2.
   Your display will have a 5, a backwards L and a 12.
2. Now press the + and enter 1 then ab/c then 1 2. Then press =.
   Your answer should be 1 followed by a backwards L followed by 2.

This means $\frac{1}{2}$ is correct because $\frac{5}{12}+\frac{1}{12}=\frac{6}{12}=\frac{1}{2}$

To do 2^6, you can always multiply 2 × 2 × 2 × 2 × 2 × 2, but it would be much simpler to key in 2 and then use the X^Y button, then key in 6 to get 64.



5.

Understanding Fractions

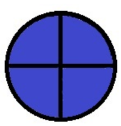
Introduction to fractions

Fraction: A number of the form which represents part of a whole, or a portion of a group.

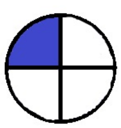
$$\frac{a}{b}$$

a = **numerator**, the top number in a fraction

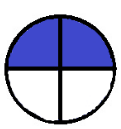
b = **denominator**, the top number in a fraction. It shows the total number of equal parts the item is divided into.



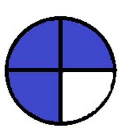
1 whole part ($\frac{4}{4}$)



1 quarter part ($\frac{1}{4}$)



2 quarters = 1 half part ($\frac{1}{2}$)



3 quarters ($\frac{3}{4}$) of a whole part

Add fractions

This diagram is of 4 quarters, in fractions it looks like:

$$\frac{1}{4}+\frac{1}{4}+\frac{1}{4}+\frac{1}{4}=\frac{4}{4}=1 \text{ whole part}$$

(They all have common denominators, so its easy to add, because all the pieces are the same size.)

Let's look at a more uneven diagram.

Adding $\frac{1}{10}$, $\frac{2}{10}$, $\frac{3}{10}$, and $\frac{4}{10}$, we get $\frac{10}{10}$ or 1 whole.

When the denominators of two or more fractions are the **same,** they are **common denominators.**

To add or subtract fractions, the denominators must be the same or common, because the pieces we are adding must be the same size. And, once we have determined what the denominator should be, we use equivalent fractions.

Example

$$\frac{1}{3}+\frac{2}{5}=$$

To answer this question, the denominators need to be the same or common.

These fractions are all equivalent fractions:

- $\frac{1}{3} = \frac{2}{6} = \frac{3}{9} = \frac{4}{12} = \frac{5}{15}$
- $\frac{2}{5} = \frac{4}{10} = \frac{6}{15}$

In the case of $\frac{1}{3} + \frac{2}{5}$, here are equivalent fractions that will give us common denominators:

- $\frac{1}{3} = \frac{5}{15}$
- $\frac{2}{5} = \frac{6}{15}$

This is because

- $\frac{1}{3} \times \frac{5}{5} = \frac{5}{15}$
- $\frac{2}{5} \times \frac{3}{3} = \frac{6}{15}$

We chose 15 as the common denominator because it is the lowest common multiple for both 3 and 5.

Thus, $\frac{1}{3}$ becomes $\frac{5}{15}$ and $\frac{2}{5}$ becomes $\frac{6}{15}$

So, $\frac{1}{3} + \frac{2}{5}$ becomes $\frac{5}{15} + \frac{6}{15} = \frac{11}{15}$

What we are really doing is taking our thirds and cutting them into fifths, giving fifteenths, and taking our fifths and cutting them into thirds also giving fifteenths.

Reduce fraction to lowest terms

Once we have a sum or difference, we attempt to reduce the new fraction to the lowest terms when possible. For this, we need numbers or factors common to the numerator and the denominator.

To reduce a fraction to the lowest terms, divide the numerator and denominator by their **Greatest Common Factor (GCF)**. This is also called simplifying the fraction.

Method: take the difference between the numerator and the denominator. Now state all the factors of this difference and eliminate all those which cannot divide evenly into both top and bottom. The factors that do remain are the only ones that can reduce the fraction.

Example

Reduce $\frac{39}{65}$.

1. $65 - 39 = 26$
2. Factors of 26 are 1, 2, 13, and 26.
3. 26 and 2 are both even and cannot divide into odd numbers.
4. The number 1 doesn't reduce any numbers.
5. The number or factor remaining is 13

$$\frac{39}{65} \div \frac{13}{13} = \frac{3}{5}$$

For example: Take two integers, 2 and 3.

Multiples of 2: 2, 4, 6, 8, 10, 12, 14, 16, 18, 20….

Multiples of 3: 3, 6, 9, 12, 15, 18, 21, 24, 27, 30

6.

Activities

Sample Questions

Adding these fractions with common denominators:

1. $\frac{5}{12} + \frac{6}{12} =$
2. $\frac{1}{4} + \frac{1}{4} =$
3. $\frac{2}{6} + \frac{6}{6} =$

Adding these fractions with uncommon denominators:

4. $\frac{5}{6} + \frac{6}{12} =$
5. $\frac{1}{8} + \frac{1}{4} =$
6. $\frac{2}{3} + \frac{1}{2} =$

Reducing these fractions to the lowest terms:

7. $\frac{30}{84} =$
8. $\frac{32}{16} =$
9. $\frac{212}{400} =$

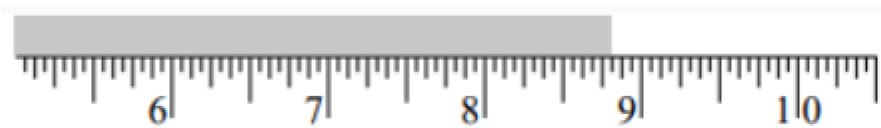
Answers: 1. $\frac{11}{12}$ 2. $\frac{2}{4} = \frac{1}{2}$ 3. $\frac{4}{3}$ 4. $\frac{4}{3}$

5. $\frac{3}{8}$ 6. $\frac{7}{6}$ 7. $\frac{5}{14}$ 8. 2.8 9. $\frac{53}{100}$

Measurement Tape

ACTIVITY

Name these measurements.

1 

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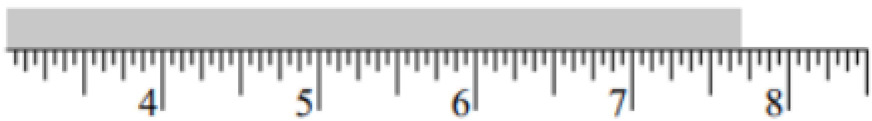
2 

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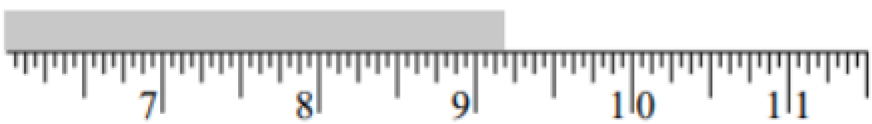
3 

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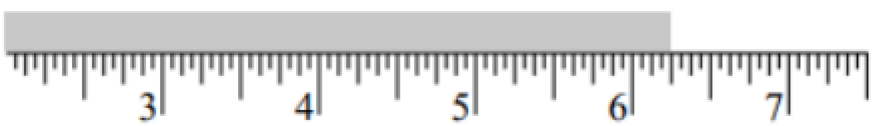
4 

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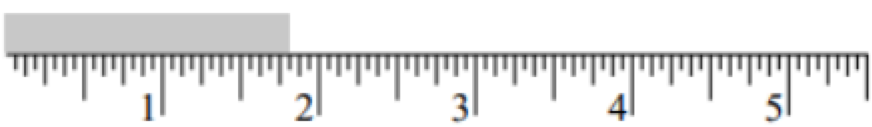
5 

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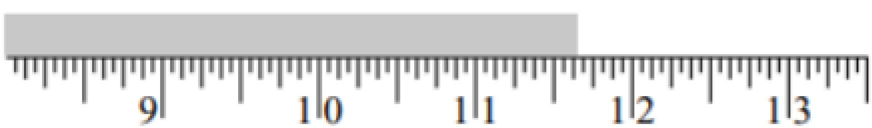
6 

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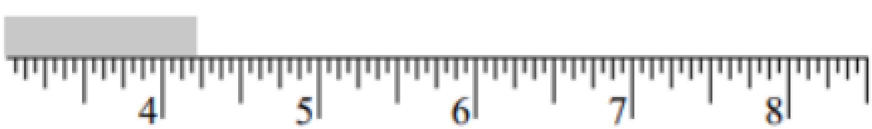
7 

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Answers: 1. 8 13/16" 2. 7 11/16" 3. 9 3/16"
4. 6 1/4" 5. 1 13/16" 6. 11 5/8"
7. 4 3/16"

Measuring Scavenger Hunt

ACTIVITY

Find the various objects around the campus grounds as listed below, then measure them and write down your answers in the blank spaces provided. (The measurement system required is given). If you are not on campus, perhaps these objects can still be found around you. Create your own scavenger hunt for you and your friends to try! Get measuring.

1. Door of classroom (inches)
    - Height:
    - Width:
2. Length and width of a tool box (in feet and inches (e.g. 6’ 7 ¾”)
    - Length:
    - Width:
3. Width of big overhead door at back of carpentry shop (meters)
    - Width:
4. Height of a work table
    - In inches:
    - In millimeters:
5. Steps (inches)
    - Step length:
    - Step width:
6. Metal locker (centimeters)
    - Height to top of lockers:

7.

Wall Hanging Project Intro: Estimation

We arrive at the shop, ready to make our Wall Hanging Projects!

This project is recommended with cedar, but you may choose any wood of your liking. The project can be stained or painted – make it your own!

We must first know how many shelves we need, based on the number of students in the class. Then, estimate the number of shelves we can get out of one slab of cedar, to figure out how many slabs of cedar we need to purchase.

Class and cedar plank sizes will vary, but this is a mock-up estimation activity for the Wall Hanging Project. You are welcome to decide on the measurements below, even make them up as you please. Wood slabs are typically sold in lengths of 6 ft to 20 ft and in thicknesses between 1 to 1 ¾ inches. It is mostly important to make sure the math is correct, and that you understand the concept of estimation for ordering materials.

Identify Measurements and Number of Students

First, we will take a look at the measurements on our Wall Hanging Project Blueprint:

- Length of shelf:
- Width of shelf:

Now we will measure out the cedar slabs we have in the shop:

- Length of cedar slabs:
- Width of cedar slabs:

How many students are making the Wall Hanging Project?

- A = Number of students =

Calculate

Now we need to figure out how many shelves we can get out of one piece of cedar.

- B = Length of cedar slab ÷ Length of shelf (from blueprint) =

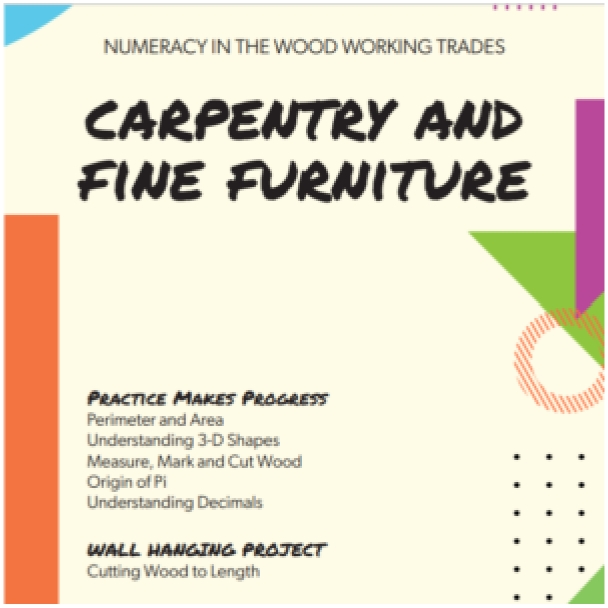
- C = Width of cedar slab ÷ Width of shelf (on blueprint) =

This number is the number of shelves you will get out of one cedar slab:

- D = B × C =
- E = A ÷ D =
- E = The amount of cedar slabs needed for your class!

II

Numeracy in Carpentry and Fine Furniture



Carpenter Tools

Carpenters use measuring tools such as the measuring tape and calculator already discussed. Here is a look at a few other measuring devices used in the woodworking trades.

Laser level

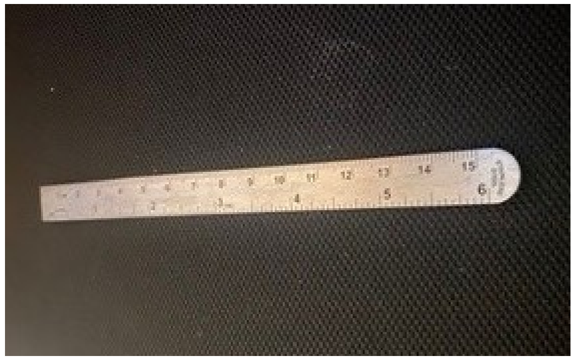
- Instantly measures any distance for up to 50 feet
- Continuous measurement feature that provides instant real-time results no matter where you point it

Framing square

- Mark walls or other materials accurately
- Framing and laying rafters and stairs
- Used as a straight-edge, finding and establishing right angles and marking cut-off work on widestock.

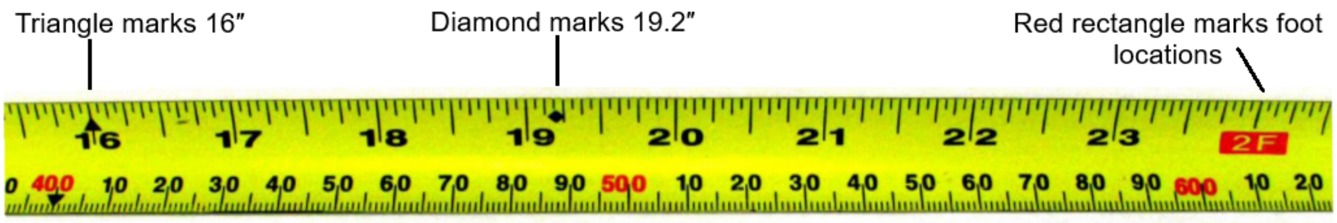
Short ruler

- Small or tight spaces
- Lining up measurement lines
- 6-inch stainless steel, fits in pocket



8.

Measuring Tape Review



Tape measure layouts.

The 16″ mark is highlighted in the picture above with a black triangle because it is used in stud layout. The 19.2″ mark is highlighted with a black diamond because it is occasionally used for floor joist layout. Every foot location is highlighted in some manner as well; the one above uses a red rectangle.

On the metric side, every 10 mm or 1 cm is numbered and every 100 mm or 10 cm is in red.

When using the metric side, the equivalent stud or joist layout marks would use a “soft conversion” where 16″ equals 400 mm, 12″ equals 300 mm and 24″ equals 600 mm. Using the metric layout would require metric-sized plywood or OSB panels, otherwise the end of an 8′ panel would not align with a stud or joist, since most panels are made in imperial sizes. This is why wood framing is not normally laid out using metric tapes in Canada.

https://projects.skillsready.ca/project/tools-tutorial-tape-measure

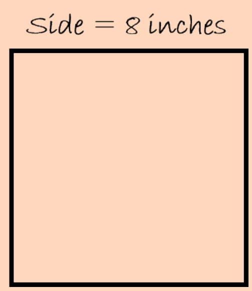
9.

Perimeter & Area

Perimeter

Example 1

Find the perimeter of a square which has a side measuring 8 inches.



Step 1: Write down the formula.

Perimeter = side + side + side + side

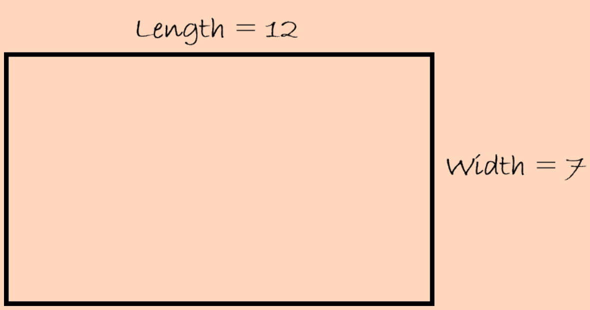
Step 2: Solve for perimeter.

Perimeter = 8 + 8 + 8 + 8

Perimeter = 32 inches

Example 2

Find the perimeter of a rectangle if the length is 12 and the width is 7.



Step 1: Write down the formula

Perimeter = (length × 2) + (width × 2)

Step 2: Solve for perimeter

Perimeter = (7 × 2) + (12 × 2)

Perimeter = 14 + 24

Perimeter = 38

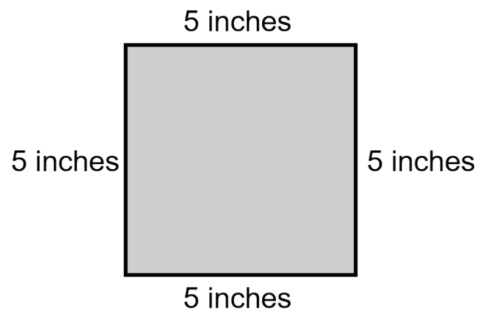
Area

Square

Area = side × side

Area = 5 inches × 5 inches

Area = 25 in^2

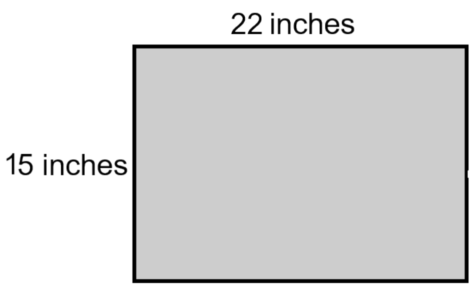


Rectangle

Area = length × width

Area = 22 inches × 15 inches

Area = 330 in^2



Text Attributions

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10.

3D Shapes and Drawings

Understanding 3D shapes and drawings

3D shapes have **faces** (sides), **edges** and **vertices** (corners).

- **Faces**: A face is a flat or curved surface on a 3D shape. For example, a cube has six faces, a cylinder has three and a sphere has just one.
- **Edges:** An edge is where two faces meet.
- **Vertices:** A vertex is a corner where edges meet.

E=F+V-2

Edges = **F**ace + # of **V**ertices – 2

The different types of three-dimensional shapes are cone, cylinder, cuboid, cube, sphere, rectangular prism, pyramid.

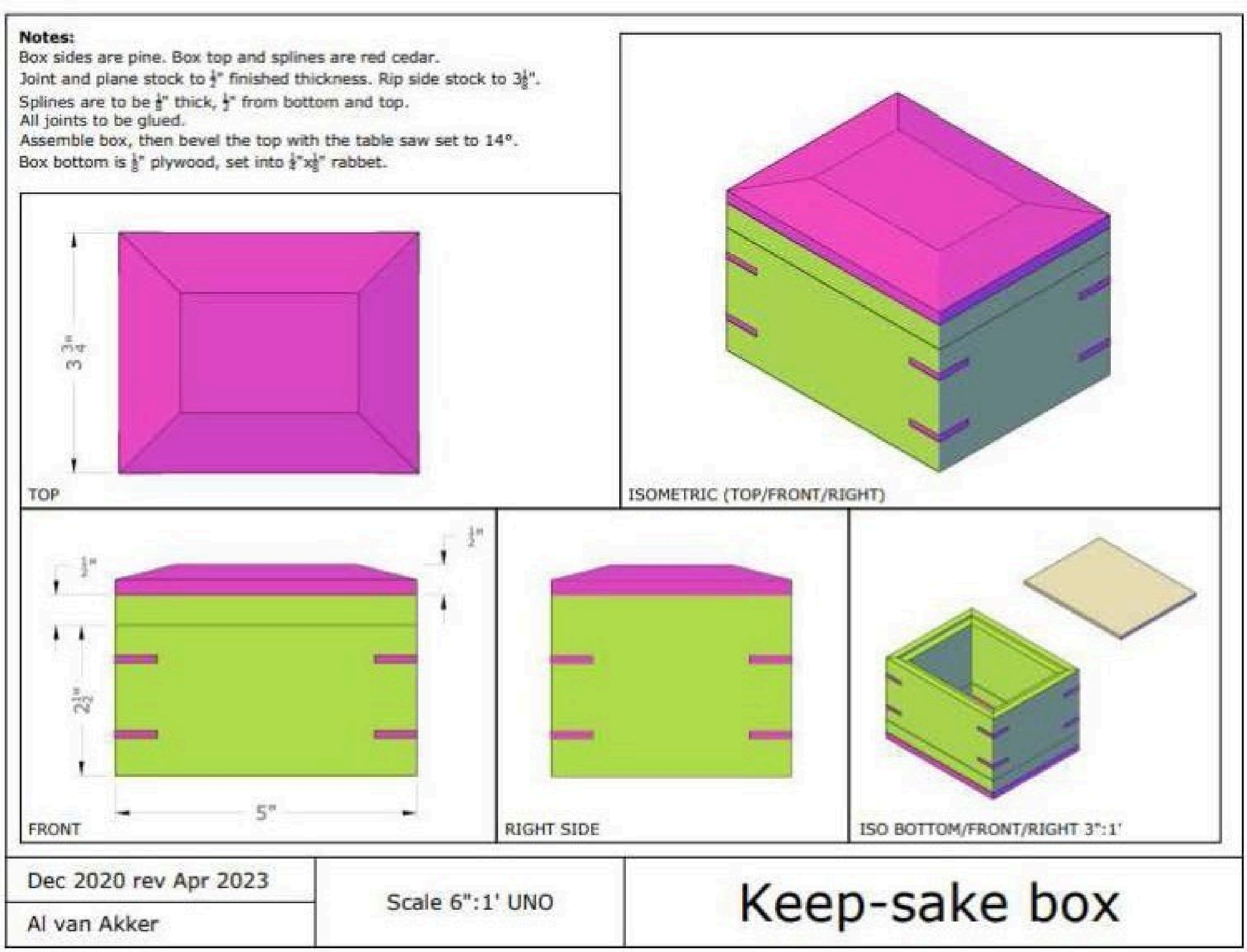
There are three major types of 3D models: solid, wireframe, and surface. We base them on the methods and techniques used to create different 3D objects. CAD (computer-aided design) offers many other types, but most fall under those three.

Although six different sides can be drawn, usually three views of a drawing give enough information to make a 3D object. These views are known as front view, top view, and end view. The terms elevation, plan and section are also used.

- **Plan views –** Floor plans, foundation plan, and roof plan
- **Elevation views –** Right, left, front, and rear elevations
- **Cross-section views**
- **Isometric views**

The Keepsake Box

Created by Al Van Akker

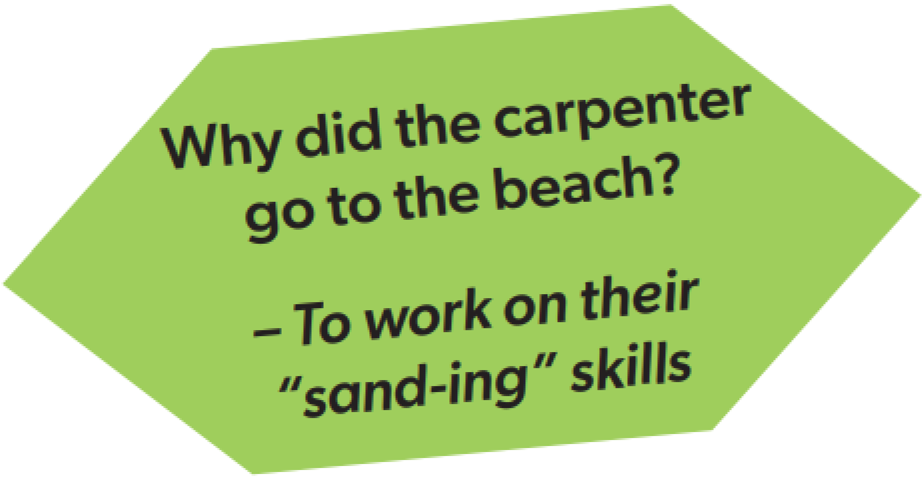


The “Keepsake Box” drawing incorporates elements and views that are commonly seen on construction drawings. The most common are the 2D (two-dimensional) views, which are called Orthographic Projections. In this drawing, we are shown the Front, Top, and Right Side views. These are drawn to scale and represent actual dimensions of the finished object. On construction drawings, they are referred to as Elevation views (Front, Back, Right, Left), or Plan views (Top). These views almost always include dimensions, which are the actual measurements that the designer wants for the finished product.

The Isometric View is a type of 3D (three-dimensional) rendering that follows some specific rules. The Vertical Axis is always shown vertically, and the Horizontal Axis for the Front View and the Right Side View is drawn at a 30-degree angle from Level. An Isometric view is different from a perspective rendering. In a perspective view, objects closer to the viewer are drawn larger, and objects that are further away are drawn smaller. This has the effect of creating axis lines that meet at a vanishing point. With an Isometric view, the axis lines remain parallel, and object dimensions parallel to an axis are drawn to scale.

Other commonly included elements include the borders and Title Block, and the Notes. The Title Block contains information about the drawing, such as the name of the project, the date, the scale, page number, and the name of the architect or designer. The Notes contain textual information that is best communicated in words rather than pictures. This can include information about materials or construction information.

We review more Blueprint information in the Metal Section of this text.

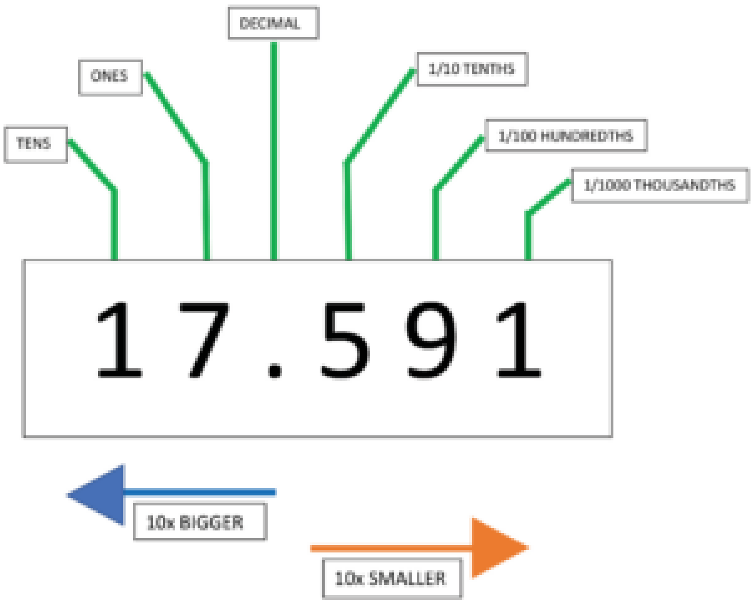


11.

Understanding Decimals

Understanding Decimals

A decimal is a number that consists of a whole and a part of a whole. Decimal numbers lie between integers and represent numerical value for quantities that are whole plus some part of a whole.



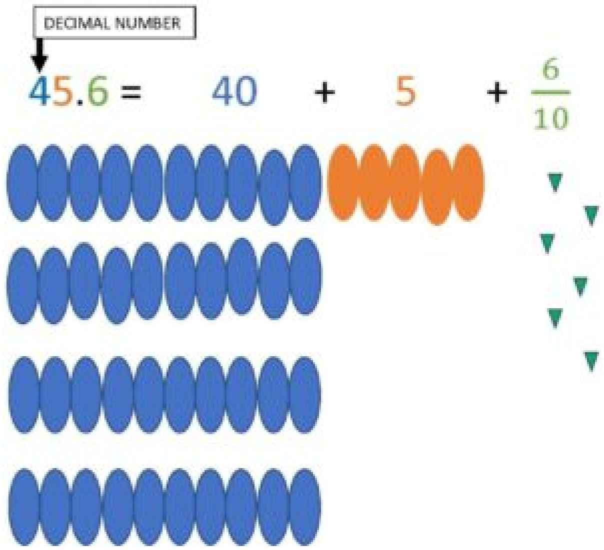
This should be read as 17 and 591 thousandths.
How to read the decimal properly: we read decimal numbers by their decimal position.

Example 1: "*forty-five and six-tenths*" written as a decimal number:

The decimal point goes between Ones and Tenths.

45.6 has 4 Tens, 5 Ones and

6 Tenths, like this chart to the right:



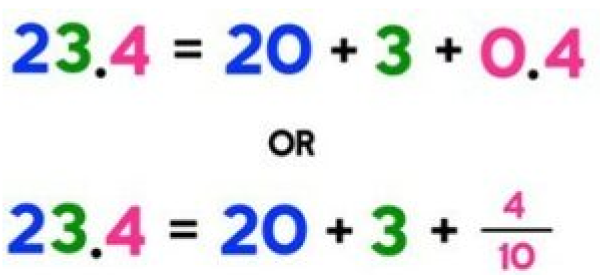
Example 2: What is 2.3 ?
On the left side is “2”, that is the whole number part.
The 3 is in the “tenths” position, meaning “3 tenths”, or 3/10
So, 2.3 is “2 and 3 tenths”

Example 3: What is 13.76 ?
On the left side is “13”, that is the whole number part.
There are two digits on the right side, the 7 is in the “tenths” position, and the 6 is the “hundredths” position.

So, 13.76 is read as 13 and 76 hundredths.

A Decimal Fraction is a fraction where the denominator (the bottom number) is to the power of 10, for example:10, 100, 1000, etc
So, 2.3 Looks like 23/10 And, 13.76 Looks like 1376/100

To convert a decimal to a fraction, **place the decimal number over its place value.** For example, in 0.6, the six is in the tenths place, so we place 6 over 10 to create the equivalent fraction, 6/10.



More Examples:

5/10 = 0.5 2/100 = 0.02 16/1000 = 0.016
1/100 = 0.01 195/10000 = 0.0195 45/10 = 4.5
*See further explanation of the power of ten in the Electrical section of this book.

12.

Mark, Measure, & Cut

https://ponyjorgensen.com/blogs/how-to-mark-measure-cut-wood/

How to measure, mark, and cut wood
March 23, 2019 Posted in How-to By Jerry

When two pieces of wood are glued together using high-quality clamps, the bond between them becomes stronger than the wood itself. But before you can break out the power tools and start assembling your woodworking projects, you need to know how to measure, mark, and cut wood properly and precisely – every time. Because if even a single piece of paper can fit between two pieces of joined wood, the glue bond isn't as strong as it could be.

Besides helping achieve good bonds and even contact, taking the time to cut every piece of your project correctly will help it all come together the way you envision, with minimal time spent sanding or making corrections. It's true that in many instances, not every cut is critical to the success of the job. But always striving to be as accurate as possible can't hurt, and being consistent will help build lasting good habits.

Measuring and marking wood before cutting

Measure, mark, then cut. Seems simple, right? Not quite. Whether you're using a ruler or a tape measure, always double-check (or triple-check!) your measurements. Then be sure to mark your wood properly. A pencil works fine as a marker, as long as the tip is sharp. And when accuracy is of the utmost importance, use a razor blade or a box cutter to make your mark. This will give you the tightest tolerance possible for perfectly accurate and straight cuts. Plus, this slight cut has the added benefit of relieving the wood grain ever so slightly, meaning the wood has less chance of splintering as you make your cut.

If you're using a pencil to make your mark, you have three options to consider before cutting the wood: you can cut to the inside of the line, along the line, or to the outside of the line. In most cases, we recommend cutting to the outside of the line. You can always take more wood off, but you can't get it back once you've started your cut. The saw blade should move just along the side of the line. If you cut to the pencil line, the thickness of your blade might take off more material than you expected. No matter what you choose, be sure to cut consistently. Follow the same approach for every cut your project requires, and you will be rewarded with accurate cuts.

Essential woodworking cuts you should know

Now that you're ready to cut your wood, let's review five of the main woodworking cuts and when to use them.

Crosscut: A crosscut is any cut that slices across (“cross”) the grain direction of the wood. To make this cut, use a miter saw or a table saw for best results. A table saw will let you cut wider pieces of wood. Avoid using a band saw, as crosscutting wood is more strenuous on a blade and a band saw is more likely to burn the edges of the wood or result in rough cuts.

Rip cut: A rip cut is a cut that follows the direction of the wood grain. Think of it as “ripping” the wood apart. This type of cut is easy to perform with most saws, and many professional woodworkers use a table saw with a rip fence for consistent, repeatable results. But use caution when you hold the wood. Never try to push a board through a table saw using just your hands; use a push stick to guide the piece forward. A good miter saw with a wide blade and a sharp edge can also be used for rip cuts.

Resawing: When you resaw wood, you cut along the edges of boards to create thinner boards. This is an ideal way to turn thick pieces of wood into thinner slabs for veneering or bookmatching. A finely tuned miter saw is the best tool for this technique. Once you’ve resawed your wood, you can run your boards through a wood planer to ensure flat surfaces.

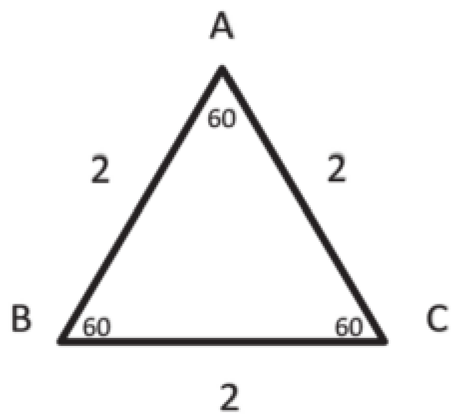
Miter: A miter cut is any cut made at an angle other than 90 degrees (i.e., not a square cut). Typically this is a 45-degree cut through the wood and is used for making boxes, picture frames, and other framing structures. Unsurprisingly, a miter saw is the best tool to use when miter cutting. A bevel cut is very similar to a miter cut, except a bevel cut is used to create angled or round edges. To make bevel cuts, hold the board’s face against the fence of your miter saw. And to be safe, set the fence so that the blade tilts away from it.

Curved cut: A curved cut is any cut that is intentionally not a straight cut. A band saw is perfect for creating curved cuts. Always cut to the outside of your mark line because you will have to round off your edges regardless. For thinner wood, a jigsaw can provide better results

13.

Origin of a 30-60-90 Triangle

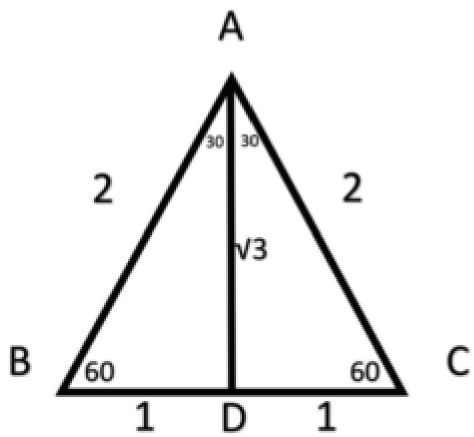
Consider the Equilateral Triangle ABC where all sides have a measure of 2 units.
Since all sides have the same measure, then the measure of each angle is 180° divided by 3 = 60°

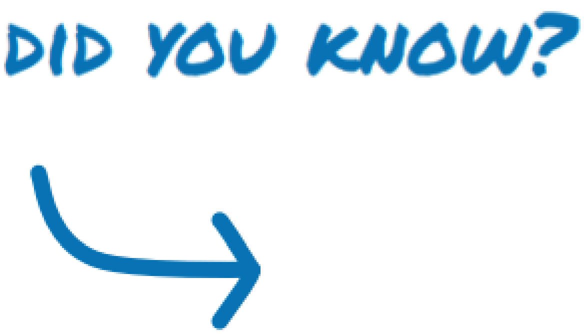


We then take ABC and cut it in two by drawing the angle bisector. From geometry, we know that in an equilateral triangle the angle bisector is also the altitude and the median. This really means that when we draw any one of these, angle A will be divided in 2 equal parts, BC will be divided in 2 equal parts, and AD will intersect BC at 90°.

In ABC, we can use The Theorem of Pythagoras to find the value of AD. Quickly, this means $2^2 – 1^2 = AD^2$ or $3 = AD^2$ giving Ö3 = AD. Thus, in a 30-60-90 Triangle, the side opposite the right angle (hypotenuse) is 2, the side opposite the smallest angle is 1, and the side opposite the 60° angle is Ö3.

We also note that the hypotenuse is always double the smallest side in a 30-60-90
Triangle.


A
30
30
2
2
√3
B
60
60
C
1
D
1


DID YOU KNOW?

Hardwoods and softwoods are distinguished by their structure, not by their strength, so, some softwoods are actually harder than some hardwoods.

At $25,000 per cubic meter, African Blackwood is one of the most expensive woods.

Wood's hardness is measured on the Janka scale, which tells you how much force is required to embed a 0.444" ball of steel halfway into the wood. Balsa, one of the softest, has a rating of just 67 lbf.

Q: Why did the 30-60-90 triangle marry the 45-45-90 triangle?

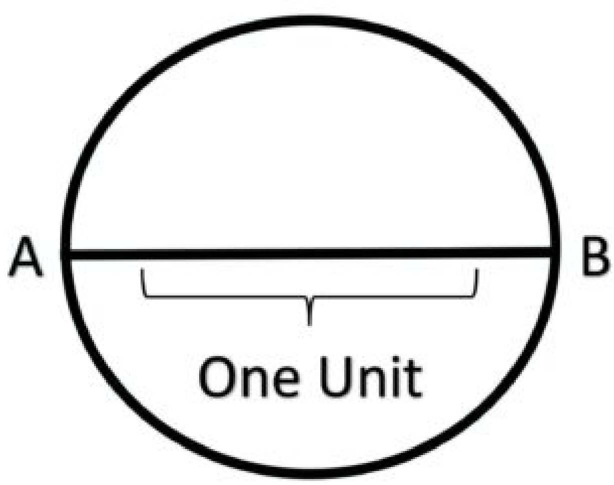
A: They were right for Each other.

14.

Origin of Pi

A wood worker must have a good understanding of geometry to produce curved surfaces. Some base their whole building on mathematical forms. Circular patios, tables, doors… it is very useful to understand working with pi when building. Pi, symbolised by π, has always been attributed to the ancient Greeks and approximated by the ratio of the circumference of a circle to its diameter which is consistently the same number π. In fact, it was Archimedes who gave it its first approximation by using polygons within the circle and outside the circle. In diagram 1, we take the measure of AB to be 1 unit and thus the circumference is π.

Diagram 1



In diagram 2, we can approximate the circumference from the outside of the circle by drawing the square CDFE. Since each side measures 1 unit, then the circumference is at most 4 units.

By Archimedes, we can draw regular polygons inside with fixed lengths to approximate the circumference. Archimedes used a 96-sided polygon from within to give and approximation of 223/71 < p < 22/7 or 3.1408 < p < 3.1429.

Later refinements and calculations gave us the decimal approximation which we have come to know today as p » 3.14159265.

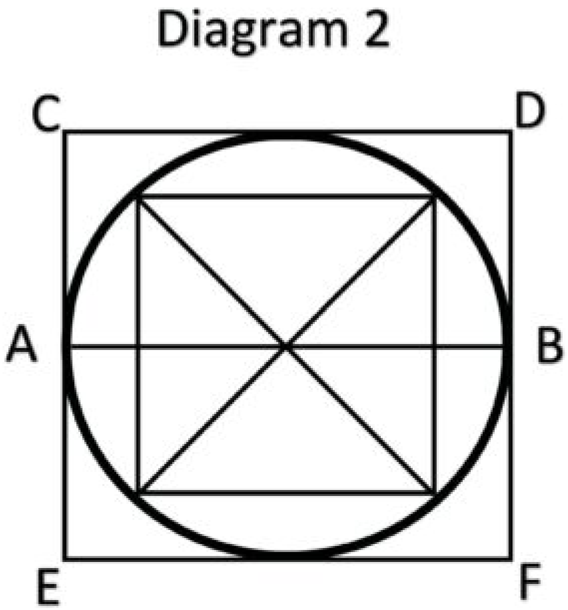


Diagram 2
C
D
A
B
E
F

15.

Indigenous in Trades Paddles

Traditional War Canoe Race Paddle

To Indigenous people, cedar wood symbolizes Life. It symbolizes that life is sacred and not to be taken for granted. When building with cedar, the Indigenous people believe the wood is to be treated as the life that it is, a being that has feelings and a being that is to be respected.

Camosun College, summer of 2023, features paddle building in their Indigenous People in Trades course. They will be building 12 paddles, 2 of 6 designs. Red cedar and Yellow cedar will be used, interchanged on the paddle. I went over the build of the paddle with Frances Wilson, who will be teaching and building alongside students. Frances was born and raised in Cowichan on Vancouver Island in British Columbia. He has participated in traditional water sports with the Cowichan Canoe Club since he was nine years old. He would spend every summer traveling and competing across the Coast Salish Territories. Frances has been building paddles nearly his whole life, grateful to have learned from his father at a very young age.

Frances and I discussed measurements and significance. Frances told me how the paddles are a replica of the traditional one-piece, deep in water, long distance paddle. Often the paddles are made without specific dimensions, and just sanded into shape, but for the sake of consistency, these paddles will go by the following dimensions:

ACTIVITY

Full Length Paddle: 5 ft
Blade Width: 6 ½ inch
Over all Thickness: 1 ½
Handle: 3 inches

Directions:

Step 1

Layout interchanged Red and Yellow Cedar. Blocks of wood are placed where they needed, on a flat surface, in the desired order and placement.

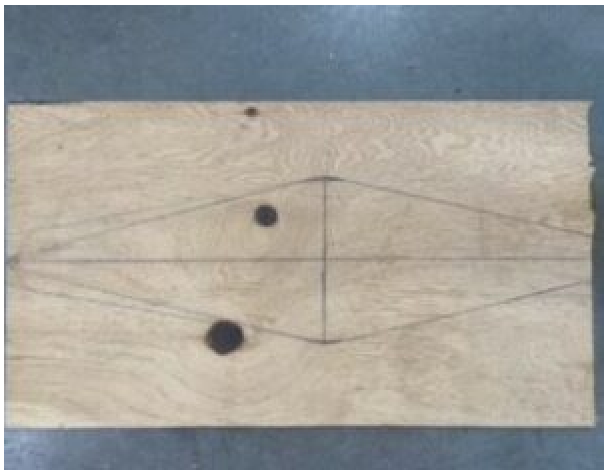
Step 2

3 ¼ inch spade drill bit used on handle with drill press, to insert paddle shaft.

Step 3:

Held together
with wood glue, then
clamped.

Step 4:



After 24 hours,
wood is cut close to
shape with miter saw.

Step 5:

Use block
plane to shape

Step 6:

Sand to
remove plane marks
and achieve desired
finish

Step 7:

wipe down
and stain

Frances Wilson

Strategic Plan 2023-2028 Camosun College

The Spirit of Camossung represents the concept of transformation as told through the Songhees legend of Camossung — where two waters meet and are transformed. In the legend, Halyas, who is said to be a transformer being, turned a young girl, known as Camossung, into stone and cast her into the narrows, near where the Tillicum Bridge is located today. After her transformation, the Spirit of Camossung
was believed to be a protector of those traveling by canoe through the Gorge to the Portage Inlet and was able to grant powers to those who swam in the narrows.

In the image, Camossung is shown gesturing the ‘raising of hands’ to honour and acknowledge the ancestors and give thanks for the ancestral lands. Above her head, she is holding six individual paddles each with a traditional symbol to represent the six priorities of the college's strategic plan. The paddles in the strategic plan image are another reference to the legend of Camossung and are also intended to represent the notion of the college community 'paddling or pulling together.' Created by local artist and alumni Dylan Thomas, the image is a modern example of traditional Coast Salish art, iconography, and semiotics.

Strengthening the Camosun Advantage – Thunderbird

The Thunderbird is known for its strength in Salish culture. In one Cowichan legend, the Thunderbird is the only one strong enough to defeat the supernatural Orca that was eating all the salmon and causing a famine.

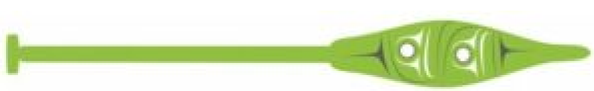
ÍY,ĆȺNEUEL OL: Doing Good Work Together – Hands Together

Two human hands come together to complete a single design. This symbolizes the teamwork that is necessary to keep any community healthy

Responding to Community Needs

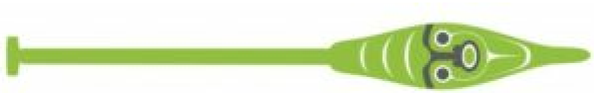
The eagle is known as mediator between earthly and spiritual realms, bringing the prayers of people to the ancestors.

Rising to the Challenges of Climate Change



The salmon are a symbol of the prosperity that a healthy environment can provide for its inhabitants.

Honouring Indigenous Resurgence



The ancestor represents the traditions and knowledge that the current generation of Indigenous Peoples is fighting to revive.

Advancing Social Justice, Equity, Diversity, & Inclusion

The supernatural mink has the ability to shapeshift and represents the diversity of human beings that share this planet.

16.

Activities

Perimeter, Area, and Pi

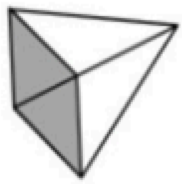
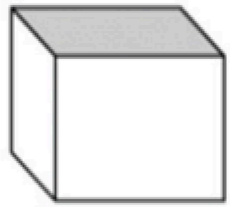
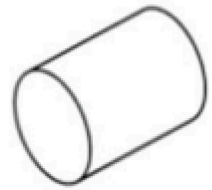
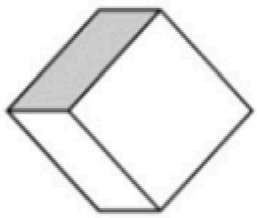
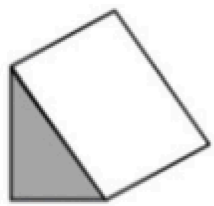
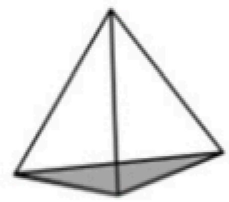
Find the perimeter and area of:

- Table tops _____
- Door _____
- Storage closet _____
- Whiteboard _____
- Shelf _____
- Hallway _____

Find the Pi of circular objects you can find around you and document them here. Ideas: door handles, doors, patios, tables, buckets, etc.

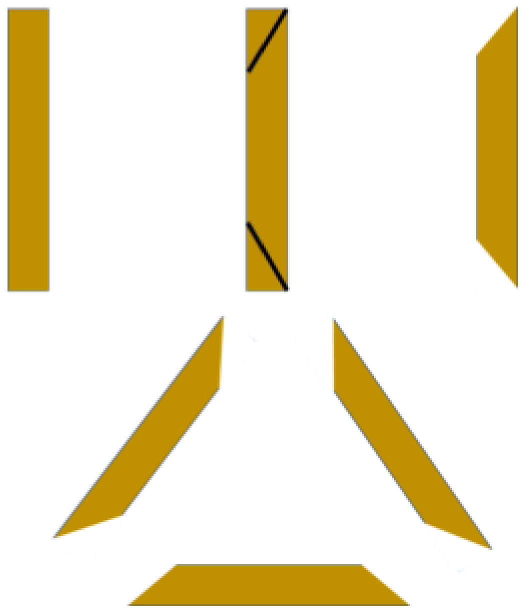
Name that Shape

Write down the name and number of faces for each 3D shape below.

		
Name of shape Faces:	Name of shape Faces:	Name of shape Faces:
		
Name of shape Faces:	Name of shape Faces:	Name of shape Faces:

Triangular prism	Cuboid	Cylinder
Square based pyramid	Triangular based pyramid	Cube

Triangle Shelf with 30° Cuts



Three pieces of wood same size

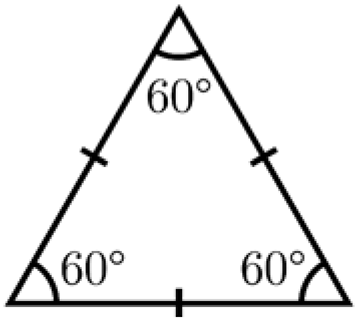
2 X 30° cuts, same direction, opposite Sides – on each piece

What you need:

- Speed Square
- 3 pieces of wood of your desired size, all equal to each other. (Recommendations: lengths of 4-12 inches, width of 1-4 inches, thickness of ½ inch- 2 inches)
- Mitre Saw or Hand Saw
- Small screws (the length of the screw depends on the thickness of wood. Make sure the screw does not protrude out of the wood.) Alternatively, wood glue can be used on this project.

30° + 30° placed together makes for a 60° Angle!

With all the cuts at 30°, placing three together makes the perfect triangle! This is called an EQUILATERAL triangle.



Directions:

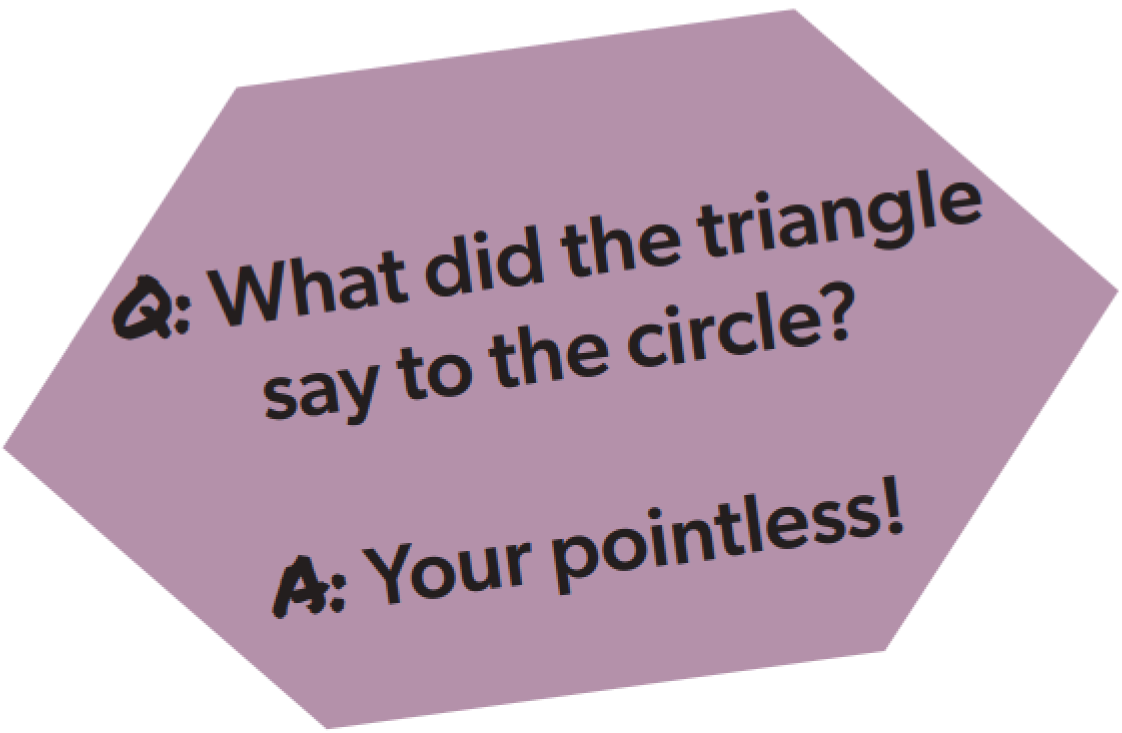
- Use a speed Square, using the square edge lined up along the length of one piece of wood and mark out 30° bevel cut
- Flip over and mark the other side, with angles/ downward slopes pointing towards each other
- Using Mitre Saw or Hand Saw, cut out two 30° angle bevels on all three pieces, exactly the same
- Glue or screw pieces together, 30° bevels flush together, to create a 60° triangle shelf
- Shelf can be hung on a nail, balancing on the upper inside of the triangle OR an option to add a bracket of your choosing

17.

Wall Hanging Project Carpentry: Measure, Mark & Cut

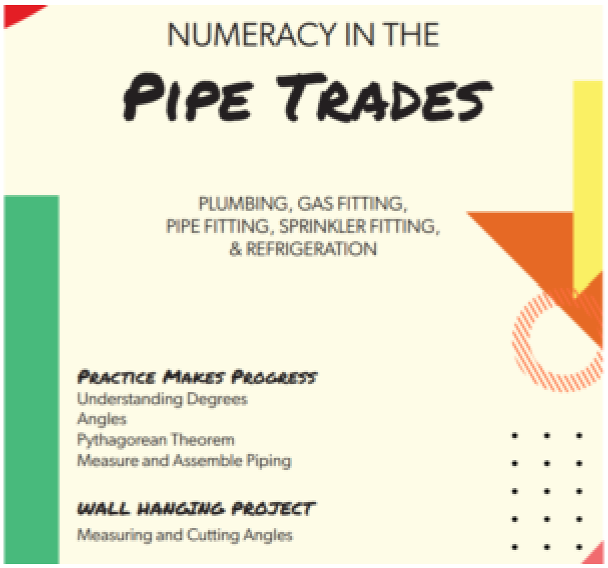
We have our measurements for our Wall Hanging Project, and we have done our estimating. **We are now ready to cut out the length of wood we need.**

Follow the previous instructions to measure, mark and cut your wood to length, before adding the angle effect. This will be covered in the next section. Cutting the wood to length first, before cutting our angles makes for a more precise shelf. A hand or miter saw will work well to cut your wood to length.



III

Numeracy in the Pipe Trades

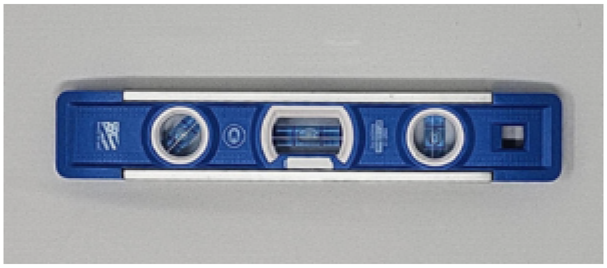


Pipe-Trade Tools

Tri-pod laser levels

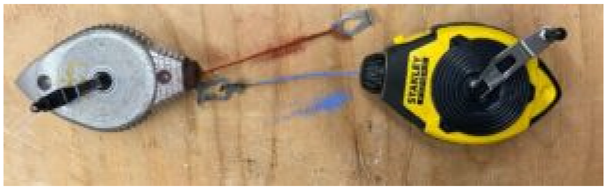
Plumbers can save time during pipe installation using the tripod laser measure, especially when installing vertical pipes from the floor to a fixture or ceiling. They save time from making multiple measurements, determining levels by holding up a bubble level, and having to make multiple marks.

Other levels



- Rotary laser levels
- Line laser levels
- Dot laser levels
- Builder's levels
- Transit levels
- Automatic levels
- Torpedo laser levels

Chalk Line



A cord saturated in chalk dust, used for marking a guide line. They speedily and accurately 'draw' straight lines between two points, and are inexpensive to purchase.

We Find Pipes Everywhere!

Used for residential, commercial, and industrial applications:

- For drinking water
- For waste drainage and venting
- Fire suppression
- Chemical, Steam Power, and Oil Refinery Plants
- To transport gas or liquids over long distances
- For compressed air systems
- For irrigation
- For high-temperature or high-pressure production processes
- It is used in petroleum industries
- Marine applications
- And so much more!!!!

Career Possibilities

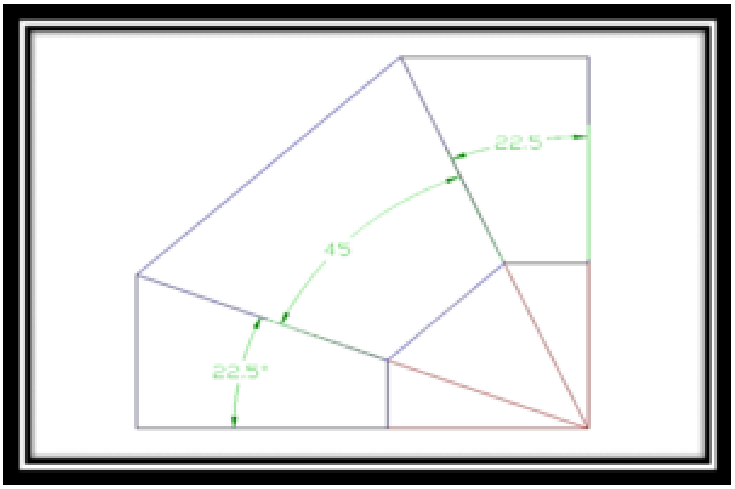
- Plumbing
- Gas fitting
- Sprinkler fitting
- Pipe fitting
- Refrigeration

Piping-related fields include:

- industrial
- residential
- commercial
- marine
- Service or new construction
- medical
- gas
- fire protection
- municipal services
- solar-system installation
- heating and cooling
- troubleshoot, diagnose, and repair
- Plus, so much more!!!

18.

Angles



A piping system is the assembly of instruments, valves, fittings, and pipes that allow for the transfer of fluid or gas from one location to another. The pipe itself is the backbone of the system.

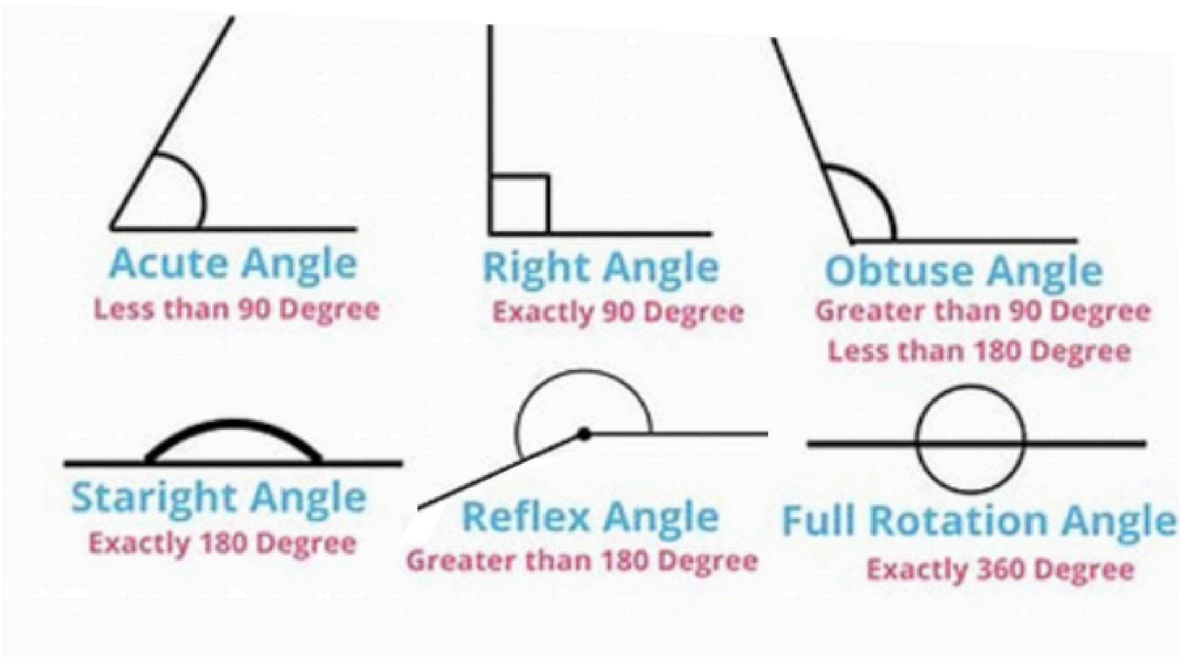
Whatever type of piping- there will be a system and a need to ‘fit up’ the pipes. This is something a Pipe Fitter would do. Here is an example…

3 Piece 90°(3 piece turn)
3 PIECES = 2 CUTS
90÷2= 45

When building a two-piece 90° turn we need to cut two pieces at 45°. When making a three-piece turn we will need to add one more piece of pipe and thus change the angle we need to cut. The plan view of the joint will look like this. A bisected joint to show what the finished angle will be.

Types of Angles

- Acute – Less than 90˚
- Right – Exactly 90˚
- Obtuse – More then 90˚, less then 180˚
- Straight – Exactly 180˚
- Reflex – Greater then 180˚
- Full rotation – Exactly 360˚



An angle can be measured precisely using a protractor, precisely. An angle is measured in degrees, hence it is called 'degree measure' One complete revolution is equal to 360 degrees, hence it is divided into 360 parts. Each part of the revolution is a degree.

19.

Understanding Degrees

We can measure **angles in degrees.** There are 360 degrees in one **full rotation** (one complete circle around).

The **degree** symbol = °

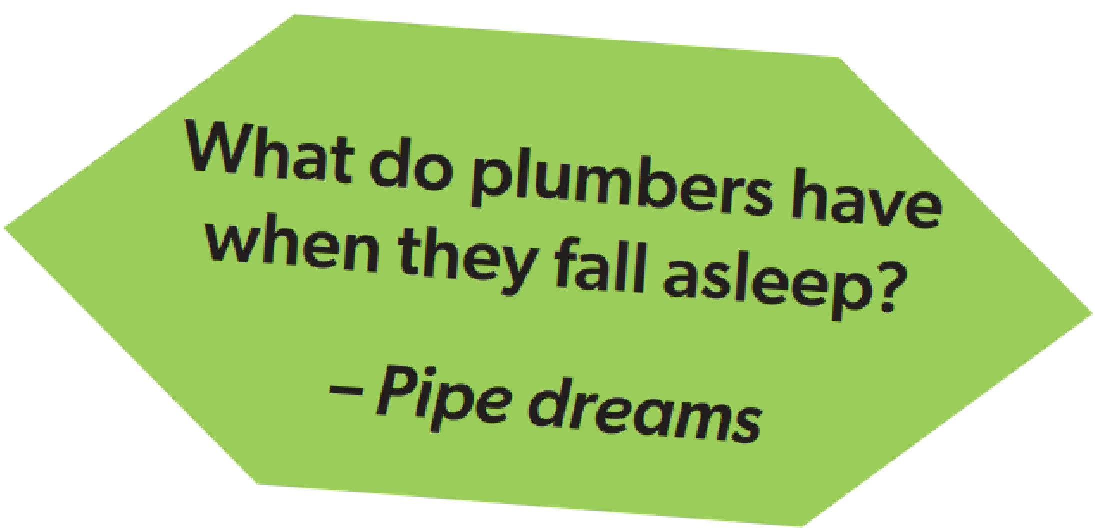
We use a little **circle** ° following the number to mean degrees.

For example, 90° means 90 degrees

A **full circle** is 360°
Half a circle is 180° (called a **straight angle)**
The **quarter of a circle** is 90° (called a **right angle**)

Why 360 degrees? Maybe because of old calendars (such as the Persian Calendar) used 360 days for a year – when they watched the stars they saw them revolve around the North Star one degree per day.

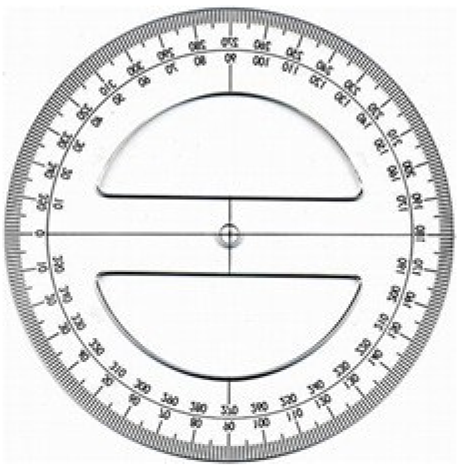
Also, 360 can be divided exactly by 2, 3, 4, 5, 6, 8, 9, 10, 12, 15, 18, 20, 24, 30, 36, 40, 45, 60, 72, 90, 120 and 180, which makes a lot of basic geometry easier.



20.

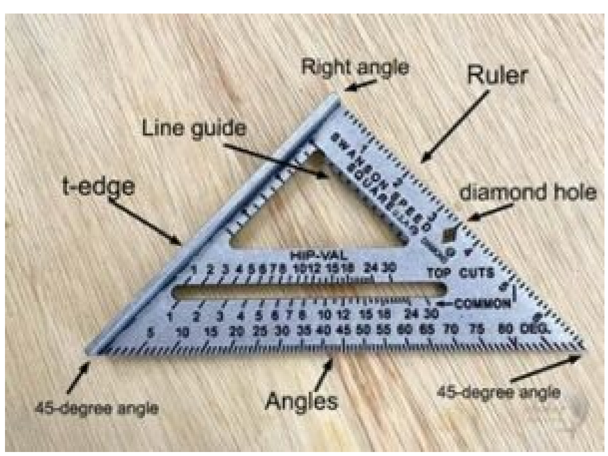
Angle Measuring Tools

How to Use a Protractor



Place the open hole of the protractor over the vertex of the angle, the point at which the two rays of an angle meet, to be measured. Line up the 0 degree line to one ray of the angle. The number that appears where the other ray intersects the outside edge of the protractor will be the angle's measurement.

How to Use a Speed Square



The most common use of a speed square is creating a square line. Simply hold the square against the long edge, you can draw a straight, square line. Speed squares can also be used for marking angles, finding pitch, and guiding saw cuts.

How to Use a Bevel Gauge

Transferring angles

1. Prepare the sliding bevel
2. Loosen the nut or screw
3. Open the blade and the handle
4. Take the angle's measurements
5. Tighten the screw
6. Transfer the angle

Creating Angles

1. Loosen the screw or nut
2. Use a protractor to create the desired angle
3. Use the sliding bevel to transfer the angle
4. Place the sliding bevel on the surface and mark the angle

21.

Pipe Sizing

When it comes to sizing pipe, there are a few considerations for how to do it and why it matters:

- How big is the hole the material will go through?
- How far is the material going?
- How thick does the wall of the pipe need to be?
- What factors are working against the system (friction, possibility of erosion, etc.)?

The pipe needs to be the proper size to handle what it's carrying (water, gas, air, drainage, etc.), but it also cannot be too small, or it could cause the volume to travel too fast. And that could cause serious issues, such as water hammer (a hydraulic shock or pressure surge), which in turn could damage the pipe system and the fixtures attached to the piping.

Days Gone By

Determining pipe sizes can be somewhat confusing, primarily because of the historical method of sizing and the fact that some current sizing still refers to those legacy systems.

Take this example:

Years ago, a half-inch pipe had an inner diameter of $\frac{1}{2}$ inches. It also had thick walls, as that was the manufacturing standard at the time.

Over the years, improved technology has enabled the walls to be thinner while retaining the same capabilities. However, to match up with existing (larger walled) pipe, the inside diameter of the new pipe had to be larger. Which means the pipe was not $\frac{1}{2}$ inch, no matter which way you measured.

When mass production of pipe began, there was a need for standardization. In 1927, the American Standards Association – which has since evolved into the American National Standards Institute (ANSI) – convened a committee to standardize the dimensions of wrought steel and wrought iron pipe and tubing. Back then, only a few wall thicknesses were used: standard weight (STD), extra strong (XS), and double extra strong (XXS), based on the iron pipe size (IPS) system of the day.

By 1939, schedule numbers were starting to come into use, but the original terms stuck and are often still used today, though XS and XXS were revised slightly to extra heavy (XH) and double extra heavy (XXH), respectively.

By the 1950s, stainless steel was coming into use more frequently, allowing the use of thinner pipes (e.g., 5S and 10S), which were based on pressure requirements. (It is worth noting that because of their thin walls, the smaller "S" sizes cannot be threaded but must be fusion welded.)

Pipe Sizing

If the legacy of sizing isn't confusing enough, consider that pipes have been sized differently over the years depending on the specific sizing system:

Alphabet Soup of Pipe Metrics: IPS, DIPS, NPS, CTS

- Iron Pipe Size (IPS) — sized by reference to the inside diameters; the standard from early 19th century through just after World War II; still used in PVC manufacturing and steel gas and water piping
- Ductile Iron Pipe Size (DIPS) — similar to NPS but used for larger pipes
- Copper Tube Sizing (CTS) — in the 1920s, this was combined with the IPS standard; the inside diameter is measured in the "types" (M, L, and K for thinnest, thicker, and thickest, respectively)
- Nominal Pipe Size (NPS) — outside diameter is fixed for a given pipe size and inside diameter varies depending on the wall thickness (referred to as "schedules"). NPS is the North American standard today. The current practice is to determine pipe size through two numbers: 1) the pipe bore (or diameter) and 2) the pipe schedule (or wall thickness) – though these two numbers can be configured in slightly different ways depending on the specific pipe used. NPS sizes are documented by a number of standards, including API (American Petroleum Institute) and ANSI/ASME (American Society of Mechanical Engineers).
- Plastic Irrigation Pipe (PIP) — used in agricultural applications; comes in pressure ratings (psi) and is available in diameters from 6″ to 24″

The Most Common Pipes Used Today

- Cast iron — mostly in use before 1960; used for drain/waste/vent (DWV) lines
- Steel (galvanized pipe) — common in older homes; lasts only about 50 years
- Plastic — used since mid 1970s; two types:
    - ABS (acrylonitrile-butadiene-styrene) — black color; first to be used in residential homes, though some areas restrict their use in new construction
    - PVC (polyvinyl-chloride) — white or cream color; rating and diameter are stamped on the pipe.

A few notes on PVC: Schedule 40 PVC is strong enough for drain lines and cold water lines, but local code will determine applicability. When used for cold water lines, it is generally not allowed for use inside a building. Schedule 80 PVC is often used for cold water lines but isn't allowed for use inside a building in some areas because it isn't suitable for hot water. CPVC (chlorinated polyvinyl chloride) is as strong as PVC but is heat resistant, which makes it acceptable in most areas for interior supply lines; it is most commonly measured with CTS standards (which is important when considering fittings for existing pipe; for example, a 2″ fitting will not always fit on a 2″ CTS pipe, but it will always fit on a 2" nominal-size PVC pipe). Schedule 40 and 80 CPVC pipe and schedule 80 CPVC fittings are available and generally used in industrial applications

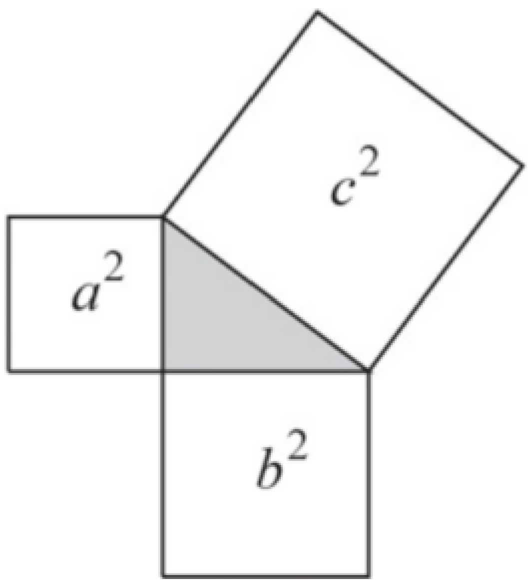
- Copper — commonly used in water lines and some drain lines; resists corrosion, lasts a long time
- Rigid Distribution Pipe — comes in three thicknesses: type M (thinnest), type L (thicker), type K (thickest)
- Rigid Drain Pipe — comes in one thickness Marked DWV and is thinner-walled than type M
- Flexible (soft) — often used with appliances lines (e.g., dishwasher, refrigerator, icemaker) and rolled out for under-slab installations
- PEX (cross-linked polyethylene) — newest pipe for residential use; easy to install (cuts easily, is flexible); it can use compression fittings or push on fittings, more permanent connections require crimp style fittings and a crimping tool

Calculating Pipe Size

Knowing the background on how and why the sizing is determined is critical, though you will not necessarily need to resort to advanced math to figure it out. Fortunately, there are tables for every type of piping that is approved for water service and distribution. These charts are used to determine pipe-size that will deliver the amount of water and at the pressure needed to operate a plumbing system that uses a variety of common household fixtures and appliances.

DID YOU KNOW?

Did you know
The square on the hypotenuse is the sum of the squares on the other two sides



Q: Why did the obtuse angle go to the beach?

A: Because it was over 90 degrees.

22.

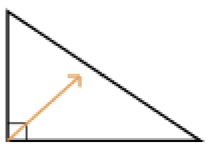
Pythagorean Theorem

The equation for the Pythagorean theorem is **$A^2 + B^2 = C^2$**

Where A and B are the lengths of the two legs of the triangle, and C is the length of the hypotenuse.

We use special words to describe the sides of right triangles.

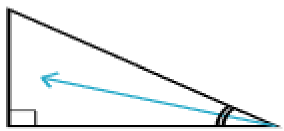
The **hypotenuse** of a right triangle is always the side opposite the right angle. It is the longest side in a right triangle.



A right triangle always has one 90 degree angle.

The other two sides are called the opposite and adjacent sides. These sides are labeled in relation to an angle.

The **opposite** side is across from a given angle.



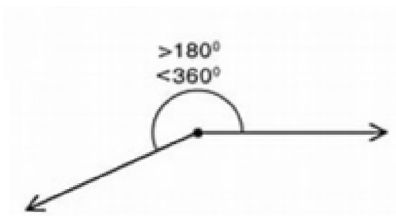
The **adjacent** side is the non-hypotenuse side that is next to a given angle.

Note: If the side opposite the right angle is the hypotenuse and the side across the given angle is the opposite, then the remaining side has to be the adjacent.

23.

Activities

Name that Angle



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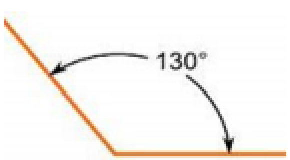

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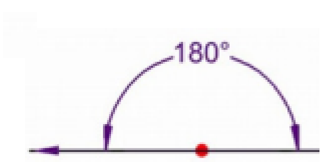

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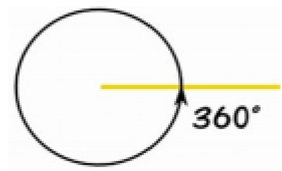

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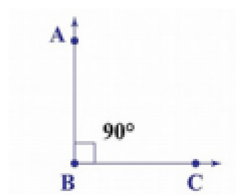

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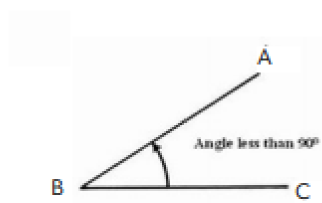


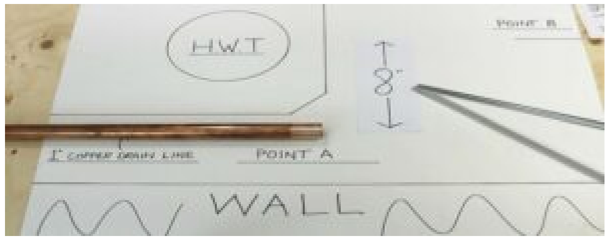
6.

Pipe Trades Magic Number 1.414

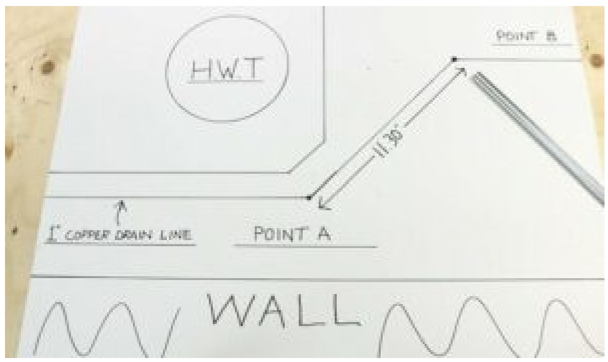
1.414 is the square root of 2. Typically, in many piping installations, you will be working to find the hypotenuse of a right angle. The three interior angles of a triangle add up to 180-degrees, in a right triangle, since one angle is always 90-degrees. So, when working with a right triangle with a 90-degree and two 45-degree angles, you would use the quick method to find the Hypotenuse (long side) by multiplying the short side by 1.414.

To find the short side, when the Hypotenuse is known, multiply it by .707.

You can use the Pythagorean theorem to find the answers you are looking for, but this is a much simpler and faster way to find your answers by using 1.414. Here is an example where a copper line needs a 45-degree offset from point A to point B.



You know that the measured difference from point A to point B is 8 inches. Multiply that by 1.414 to find the Hypotenuse. Now you know that the Hypotenuse is 11.30 inches.



Don't forget to take off your Fitting Allowance before you cut your piece of pipe!

Pipe fittings are a necessary part of any piping system. When you need to connect two pipes or a pipe with fittings, you need a perfect length. Fitting lengths can be a little confusing, but with a little bit of calculation, it's easy to get the right length for your needs.

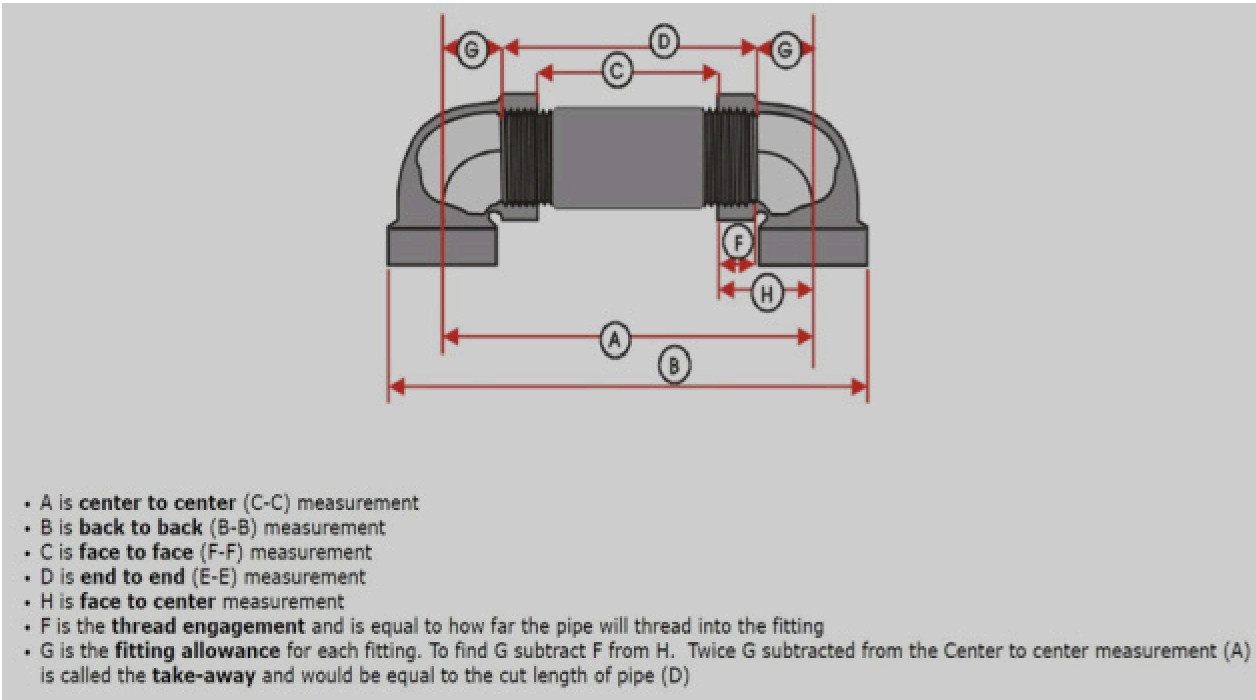
Calculating pipe length with fittings is a simple process that can be done quickly and easily. By knowing the dimensions of the fitting and the length of pipe needed, calculating pipe length can be done quickly and with accuracy.

Measure and Assemble Piping Using Fitting Allowances

Written by Andrea Durdle, RSE

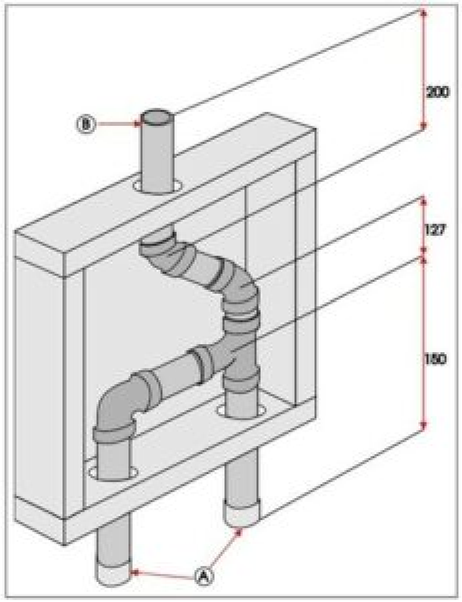
Plumbers are required to measure, cut and assemble piping for drainage, venting, heating, process piping and water systems. In order to properly plan work, plumbers must use the concept of fitting loss calculations and basic mathematics involving addition, subtraction and fractions to create a cut list for materials.

Fitting loss calculations take into consideration how far piping will go into a fitting and where the fitting's center line will line up where piping may extend through walls and ceilings. Calculating fitting losses not only helps a plumber plan their installation, it also helps them in determining the amount of material required for a job before the work begins. Below is an example of some terminology that applies to fitting loss calculations.



The most common fitting loss calculations a plumber uses are to calculate center to center measurements as illustrated by letter A above. To practice using basic mathematics and fitting loss calculations you will measure and assemble components commonly used in a residential venting system. All plumbing systems require venting; have you ever wondered what the black plastic pipes sticking out from the roofs of houses are? They're vents for the plumbing system, they serve a few purposes. First, they allow sewer gases to have a path to escape outside of the home. Secondly, their primary their primary function is to allow for proper drainage allowing air into the system. Have you ever held a full pop bottle upside down and watched it pour in big glugging slugs? But when you turn it slightly to the side and air is allowed in, the pop pours smoothly and quickly. The same principle applies to your plumbing system, without air in behind the water in the drains, things would flow very slowly and create problems in the drainage system.

To complete this activity, look at the drawing of a venting system below. Notice that some, but not all measurements are given. In the field plumbers would be required to measure based on the layout of the plumbing system and the features of the construction in the home to create a cut list. You will be assembling this venting system in a wooden box that looks like the one in the image below. You will only be dry-fitting the fittings and pipe together, so that they can be reused. In a real installation, a plumber would glue the piping and fittings together.



In the box, you will have many different fittings to assemble, along with piping cut to predetermined lengths. The fittings in the box will include; 90-degree bends, 45-degree bends, and a sanitary tee (this tee is directional to provide better drainage flow). Your task will be to use a measuring tape and fitting allowance logic to match the measurements on the drawing above to the piping available and install the piping and fittings, so they do not bind in the holes in the wood box. Note that the further the piping engages into the fitting the closer in accuracy your measurements will be.

DID YOU KNOW?

Where did .707 come from?

square root of 2 = 1.4142
square root of 2 ÷ 2 = .707

24.

Wall Hanging Project Pipe: Cutting Angles

Mark and Cut an Angle on Your Wall Hanging Project

Now that we have our shelf cut to length it is time to practice laying out angles.

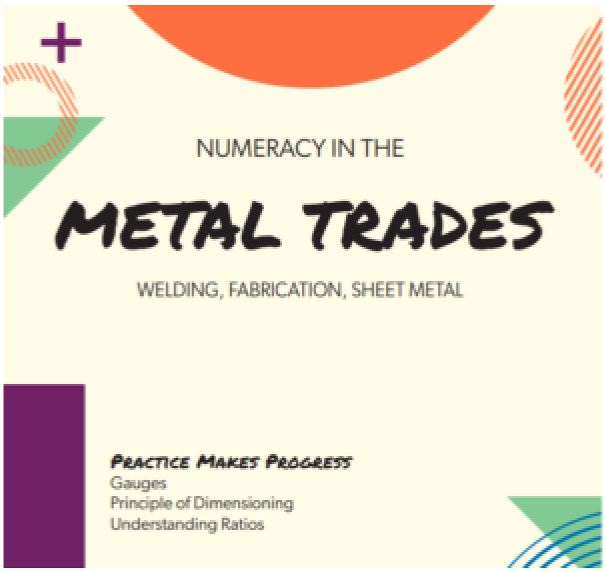
Try out all the different hand-measuring tools and decide which works best for you. Keep in mind the "measure twice, cut once" rule of thumb.

Miter cuts are angled crosscuts, which most often measure 45 degrees. The Wall-Hanging Shelf will have a 30-degree angle on it.

1. Measure to the long end of the miter, and set your combination square or layout square on the mark.
2. Draw the cut line.
3. Check your mark with a protractor.
4. A hand saw or miter saw will work well for cutting your angle.

IV

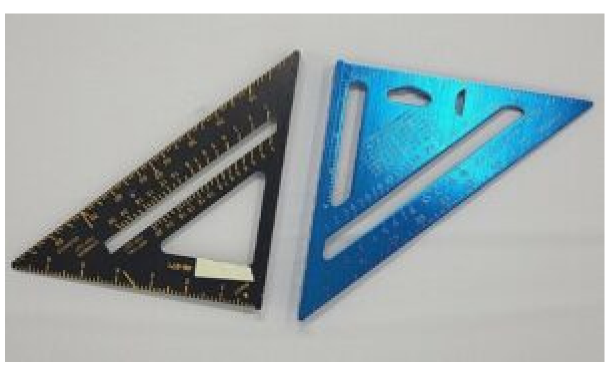
Numeracy in the Metal Trades.



Metal-Trade Tools

Squares-Combination, Speed, Tri

Metal Fabricators will undoubtedly use a square on a regular basis. A square is a must-have measurement tool for any professional. It is used to determine correct angles and layout markings. On the market, there are a few distinct sorts of squares.



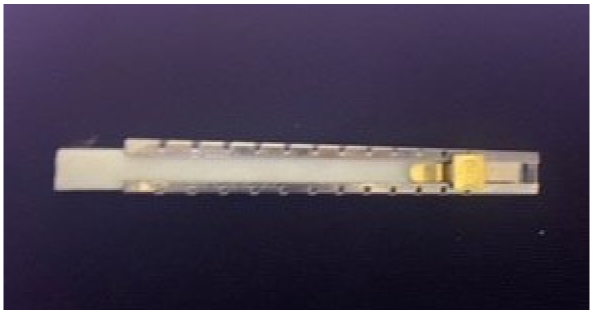
Compass-Trammel Points

A compass will be an indispensable tool for a variety of tasks. It’s used to create circles and can be used to figure out how far two locations on a map are apart. This is a common material in shipbuilding.

Soapstone, Paint Markers & Sharpies

Welders and Fabricators use soapstone to mark out measurements and needed notes on metal. Soapstone creates visible marks that are heat-resistant and can be easily removed. Soapstone is to a metal worker as a pencil is to a wood worker. Soapstone can be sharpened on a file for accurate markings.

Paint Marker also is used for certain applications but is harder to remove. Sheet metal workers can easily use a Sharpie to mark up their sheet metal.



25.

Gauges

Understanding Gauges

Definitions for gauge:

noun

1. an instrument or device for measuring the magnitude, amount, or contents of something, typically with a visual display of such information.
2. the thickness, size, or capacity of something, especially as a standard measure.

verb

1. estimate or determine the magnitude, amount, or volume of.
2. measure the dimensions of (an object) with a gauge.

Gauges Seen in Metal Industry

Gas gauges on compressed gas cylinders

In many welding processes, a gas, or a combination of gases is needed to perform a proper, passable weld. Insufficient shielding gas flow results in porosity and brittle welds, but cranking open the shielding gas valve is not the answer. You can make things worse by using a shielding gas flow that is too high.

Gas bottles used in welding shops have a pressure gauge that measures fluid, gas, water, or steam intensity in a pressure powered machine to ensure there are no leaks or pressure changes that would affect the performance of the system. These pressure systems are designed to operate within a specific pressure range needed for the process.

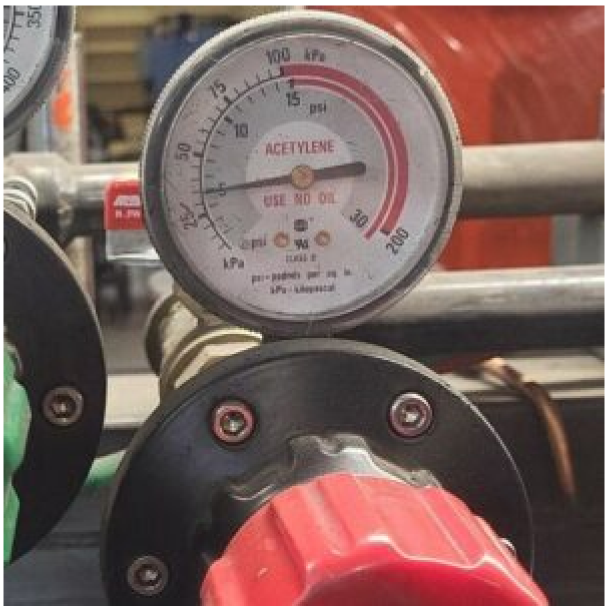
Gauge pressure is pressure which is relative to normal atmospheric pressure. It deviates pressure away from standard atmospheric pressure. Gas bottle pressure gauges are measured in several different ways, including bar and psi, and is used worldwide.

Flowmeters indicate the amount of liquid, gas, or vapor moving through a pipe or conduit by measuring linear, non-linear, mass, or volumetric flow rates. Gases are not only used to produce a proper weld, but also to tear them apart.

Oxy-Acetylene fuel cutting is one of the most used, nationwide cutting methods.

Many shops have them set-up in manifolds, but portable individual set ups are not uncommon either. Safety and a precision set up are of the most importance. Take notice to what is done to the various valves and regulators below:

Assemble a portable oxy-acetylene unit



1. Secure the cylinders (bottles) to the portable cart with proper rigging
2. Remove the cylinder caps and place them aside in a secure spot
3. Crack (open slightly and close immediately) the cylinder valves with your face pointed away. This is done before the regulators are attached to clear the valve of dust, dirt or anything unclean that may otherwise enter the regulator.
4. Attach the cylinder (bottle) Pressure Regulators. Be sure to not over-tighten.
5. Install the flashback arrestors (safety feature)
6. Connect the Gas hoses
7. Open the cylinder valves
8. Purge (blow out) the cylinder pressure regulators and gas hoses. This is a safety procedure

that removes any dirt or debris before attaching the torch. Debris in the system can block small orifices and potentially be flammable

9. Connect the cutting torch
10. Set the working pressure by turning the pressure adjusted screw, until the working pressure gauge reads the preferred working pressure
11. Purge the closed system and check for leaks.

Welding gauges

On a completely different note from gas gauges, welders also use a different type of gauge, called a fillet (weld profile) gauge. Most are made of stainless steel, so it doesn't rust.

Sheet metal

A sheet metal worker deals with meticulous measurements. Sheet Metal workers work with millimeters or inches and different 'gauges. The gauge systems history starts in the wire industry, to describe the diameter of the metal wire so that wire drawers could quote metal based on the number of draws they had to perform to achieve a certain diameter. Since then, it has become the primary way of describing the thickness of both wire and sheet metal.

IMPORTANT NOTE: the gauge system is completely separate from both the metric and imperial measurement systems.

There are slightly different gauge measurements for different types of metals. The term gauge, in this case, is derived from weight. There are different measurements depending on the type of sheet metal being used, so a conversion chart should be consulted to ensure that the tools and processes being used fit the parameters for the job. A quick way to find the gauge equivalent to a measurement in inches or millimeters is by using a conversion chart like the one below:

Gauge chart

Gauge Chart

Gauge	Standard Steel Thickness (inches)	Galvanized Steel Thickness (inches)	Aluminum Thickness (inches)
3	0.2391	–	0.2294
4	0.2242	–	0.2043
5	0.2092	–	0.1819
6	0.1943	–	0.162
7	0.1793	–	0.1443
8	0.1644	–	0.1285
9	0.1495	0.1532	0.1144
10	0.1345	0.1382	0.1019
11	0.1196	0.1233	0.0907
12	0.1046	0.1084	0.0808
13	0.0897	0.0934	0.072
14	0.0747	0.0785	0.0641
15	0.0673	0.071	0.0571
16	0.0598	0.0635	0.0508
17	0.0538	0.0575	0.0453
18	0.0478	0.0516	0.0403

An even easier way to measure the gauge of your materials is by using a material thickness gauge:

What kind of music do welders like?

– Heavy metal

26.

Principals of Dimensioning

Metric and Imperial Conversions

Most shops have conversion charts that give the conversions between the metric and imperial systems most useful to your trade. Specification guides will usually give you both metric and imperial measurements if appropriate.

Converting units of length

Convert 12 inches to cm

12 inches X 2.54 cm / 1 inch = 12 X 2.54 cm = 30.48 cm

38 mm X 1 inch / 254 mm = 38 X 1 inch /254 = .1496 inches

——————————————————————————-

Convert 123 miles to kilometers.

1 mile = 1.609 km

Geometric Shapes

When we think of geometry, we usually think about angles, circles, triangles, and squares. Geometry is simply the study of points, lines, planes, and space. Almost every machine or handmade construction involves using geometry; walls must be straight, fences must be level, and shapes have to be fitted properly. Whenever triangles, rectangles, and circles are constructed, geometry is being used.

Principles of Dimensioning

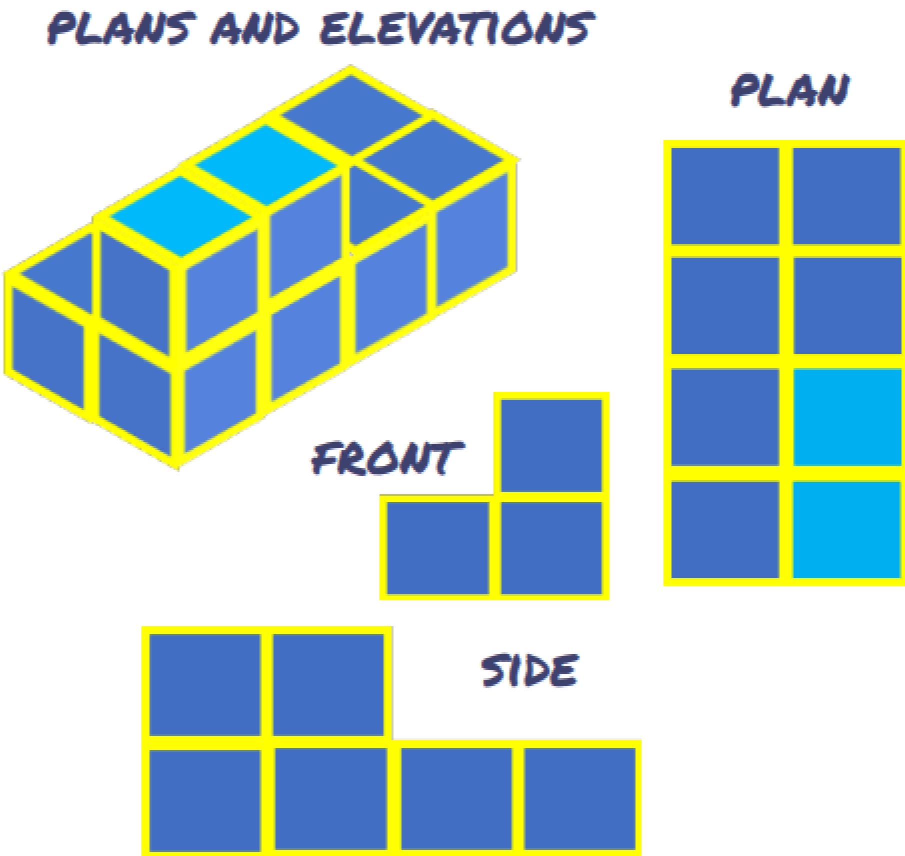
A good sketch of an object is one that you can use as a blueprint to manufacture the object. Your sketch must show all the necessary dimensions of the part, locate any features it may have (such as holes and slots), give information on the material it is to be made from, and if necessary, stipulate the processes to be used in the manufacturing of the object.

Plan and Elevation Views

In order to get a better perspective on anything in life, we have to look at it from many different angles. Plans and Elevation views in Blueprint drawings are a way of showing a 3-dimensional objects on paper.

There are 3 views to a 3-D shape:

You see the elevations in the front and side views, and the top of the 3-D object is known as the Plan View.



27.

Decimal Review

The **decimal system** is based on powers of 10, so let's take the WHOLE number 1 and divide it into ten parts. These are called tenths. Each of those tenths looks like 1/10. If we divide 1/10 the decimal equivalent is 0.1. If we divide 0.1 into tenths we have 1/100 or 0.01, which is called one-hundredth Because 1/10 ÷ 10 = 1/10 X 1/10 = 1/100 = 0.01

Dividing and Multiplying Decimals

Any number can easily be divided or multiplied by 10 simply by moving the decimal point in the number. All numbers have a decimal point. If it is a whole number or integer such as 7, the decimal point falls after the number such as 7. If it is exactly 7, it can be written as 7.0. If you needed to multiply it by 10, you would move the decimal point to the right one place because 10 has one zero on it. So 10 × 7.0 would be 70.

To divide by ten or a power of ten, you move the decimal point to the left by the same number of places as the number of zeros or decimal places in the number you are dividing by.If a number already has a decimal point in it, start with that decimal point.

Multiplying Decimals Rule of Thumb

Multiply the whole numbers without the decimals to start.
4.22 × 3.1 = ?

Start with:
422 × 31 = 1302

Now, there are 2 decimal places in 4.22 and 1 decimal place in 3.1. This is a total of 3 decimal places. We then put three decimal places in 13082 and we finally get the answer: 13.082

Dividing Decimals Rule of Thumb

Divide the number as you normally would, using long division by a whole number.
9.24 ÷ 7.008 = 74

Rule: We cannot divide by a decimal, just whole numbers.

Here to make 7.008, we multiply it by 1000 (3 decimal places).

But, if we multiply the bottom by 1000, we must multiply the top by 1000.

Thus, 9.24/7.008 becomes 9.24/7.008 X1000/1000 = 9240/7008 = 1.3185

You want the divisor 7.008 to be by a whole number because we cannot divide by a decimal. So, you need to move thedecimal point 3 places to the right:

7008 – Now you need to move the decimal point for the dividend 3 places to the right:

9240 – In this case you have to add a zero to move it 3 places.

Now you divide 9240 by 7008 to get the answer:

Practice Questions

ACTIVITY

1. 0.3 × 0.008
2. 3.35 × 8
3. 45.8 × 6
4. 5/4 ÷ 0.8 (keep in mind: (a/b)÷(c/d) = (a/b) × (d/c))
5. When a fraction is divided by 1, the quotient is equal to:
6. 90.16 ÷ 9.2

Answers:

1. =0.0024 2. =26.8 3. =274.8 4. 25/16 5. Itself 6. =9.8

DID YOU KNOW?

Welding can be done underwater and in outerspace! Welding is dated back to 4000 BC when the Egyptians were building the ancient tombs, by pressure welding lap joints. Pictures depicted of tools and metal working were found on the walls of the ruins.

28.

Fraction Review

$$\frac{\text{Numerator}}{\text{Denominator}}$$

Common Fractions –

Improper Fractions – have a numerator larger than the denominator (greater than or equal to)

Proper Fractions – have a numerator smaller than the denominator (less than)

Equivalent Fractions – may look different but they have the same value

Mixed Numbers – have a whole number part and a proper fraction part

Reduce – to convert the fraction to the lowest equivalent fraction

Invert – to turn upside down

Subtraction and Addition

To subtract or add, fractions must have the same denominator. Just as in whole number subtraction, you may have to 'borrow' when subtracting mixed

Multiplication

1. Convert all mixed numbers to improper fractions
2. Reduce all the fractions to the lowest terms
3. Multiply tops by tops, then bottom by bottom

Division

1. Change all mixed numbers to improper fractions
2. Invert the divisor
3. Multiply

4. Reduce the answer if possible – reduce then multiply

29.

Understanding Ratios

A**ratio** is the comparison of two or more objects.

A ratio of two numbers a and b can be written as

$$a : b \text{ or } \frac{a}{b}$$

A ratio of three objects a, b, and c, is usually written as

$$a : b : c$$

A proportion is the comparison of two or more ratios:

$$\frac{a}{b} = \frac{c}{d} = \frac{e}{f}$$

For example, if there is 1 boy and 3 girls you could write the ratio as:

$$1 : 3 \text{ (for every one boy there are 3 girls)}$$

A Ratio Compares Values

A ratio says how much of one thing there is compared to another thing.

There are 2 green squares to 5 yellow squares.

The three ways to write this are $2 : 5$, 2 to 5, or $\frac{2}{5}$

You can “scale up” your ratio like this:

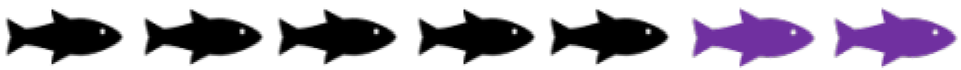
$$4 : 10$$

The trick with ratios is to always multiply or divide the numbers by the same value.

$4 : 10$ is the same as $4 \times 2 : 10 \times 2 = 8 : 20$

Everything you have read so far is part-to-part ratios. Ratios can also be a part compared to the whole number.

There are 7 fish, 5 are black and 2 are purple.



- **Part to part:**
    - The ratio of black to purple is $5 : 2$ or $\frac{5}{2}$
    - The ratio of purple to black is $2 : 5$ or $\frac{2}{5}$
- **Part to whole:**
    - The ratio of black to all fish is $5 : 7$ or $\frac{5}{7}$
    - The ratio of purple to all fish is $2 : 7$ or $\frac{2}{7}$

Blueprints

When we read blueprints in the trades, it is not often that the picture is the actual size of the object. Therefore, a ratio needs to be given to understand the scale at which the dimensions are shown in the picture compared to the real-life-sized object being built.

A scale is shown as a ratio, for example $1 : 100$. A drawing at a scale of $1 : 100$ means that the object is 100 times smaller than in real-life scale $1 : 1$. You could also say, 1 unit in the drawing is equal to 100 units in real life.

A machine part, for example, may be half the size ($\frac{1}{2}''$ = $1''$); a building may be drawn $\frac{1}{48}$ ($\frac{1}{4}''$=1’-0”); a map may be drawn $\frac{1}{200}$ size (1”=100’-0”); and a gear in that wristwatch may be ten times size (10″ = 1″).

Blueprint drawings are typically drawn in

- $1 : 20$, $1 : 50$ or $1 : 100$ (Metric units) or
- $\frac{1}{4}''$ or $\frac{1}{8}''$ (Imperial units) scales

To scale a Metric drawing

Multiply the measurement on the drawing with the denominator where the denominator is the number after the colon.

Example – Blueprint Drawing Scale $1 : 50$

An actual length of 1 cm is measured on a $1 : 50$ blueprint floor plan. The physical length can be calculated as

(1 cm) 50 = 50 cm

Imperial units – US

A $\frac{1}{4}''$ scale means that each $\frac{1}{4}''$ (inch) on the plan counts for 1′ (feet) of actual physical length.

To scale a blueprint in imperial units to actual feet, multiply the measurement on the drawing (in inches decimal equivalent) with the denominator where the denominator is the bottom number.

Example – Blueprint Drawing Scale $\frac{1}{4}$

An actual length is measured to 1-3/8” on a $\frac{1}{4}$ blueprint floor plan. The physical length can be calculated as

(1-3/8 inch) 4 = (1.375 inch) 4

= 5.5 feet

= 5′ 6″

If you know the measurement of the actual object, and have the ratio scale, you would **divide** the number of the real life measurements by the denominator of the ratio.

Commonly Used Drawing Scales

Details

- $1 : 1$
- $1 : 5$
- $1 : 10$
- $1 : 20$

Component drawings, assembly

- $1 : 20$

- $1:10$
- $1:5$

Floor plans, general arrangement (GA)

- $1:40$
- $1:50$

Location plot plans

- $1:80$
- $1:100$
- $1:200$
- $1:500$

Block plan, city maps, and larger

- $1:1000$
- $1:1250$
- $1:2500$

Ordnance survey maps

- $1:100000$
- $1:50000$
- $1:25000$
- $1:10000$

30.

Hole Layout

In industry hole lay out is a big part of many welders' and fitters' daily tasks.

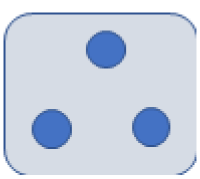
The **weld access hole** or **rat hole** is a structural engineering technique in which a part of the web of an I- beam, Stringer or T-iron, is cut out at the end or ends of the beam. The hole in the web allows a welder to weld the flange to another with a continuous weld on the interior/web side of flange welds. Without the weld access hole, the middle of the flange would be blocked by the web and inaccessible for welding.

The symbol used for a hole is the diameter **'Ø'** symbol.

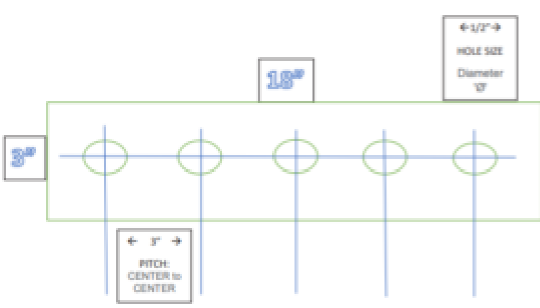
Ø

Other hole lay out possibilities in industry:

- Flange Hole Lay Out
- Weep holes for drain and man hole covers
- Bolt Hole Lay Out
- Plug Welds to secure to metal (Plug welds secure the middle of plates etc., and are most often seen on wear plates and sacrificial/expendable parts like wear strips on excavator buckets.)



[Hole Centers and Spacing](#)



Pitch and Gauge

Width of hole w = smallest dimension, i.e. diameter of round hole, edge length of square hole, and width of long hole.

Length of hole l = length of long hole (largest internal dimension).

Pitch of holes t: The pitch is defined as the distance from center of hole to center of hole in two adjacent rows.

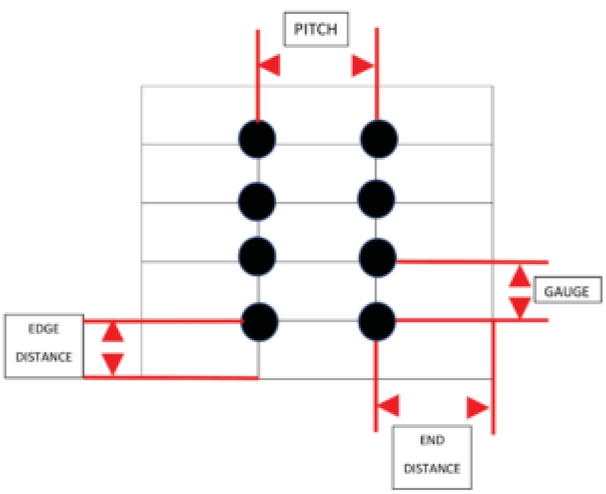
Width of bridge c: This signifies the smallest unperforated space between 2 holes in adjacent rows.

Note: t = w + c

Move up drill bit sizes – called stepping up

*Start hole in a precise location

Double check measurements with a trammel point.

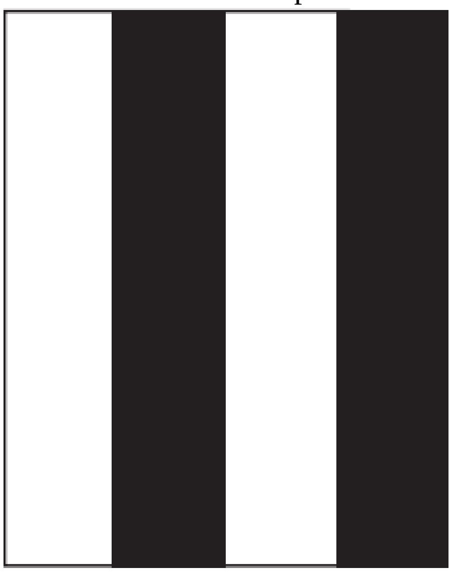


31.

Activities

Questions

1. Write a fraction that represents the shaded area below:



2. Review the fraction with the indicated numerator. $\frac{3}{5} = \frac{?}{30}$
   A. $\frac{18}{30}$
   B. $\frac{6}{30}$
   C. $\frac{3}{30}$
   D. $\frac{15}{30}$
3. Write the given decimal as a mixed number: 30.425
   A. $\frac{3017}{400}$
   B. $\frac{30,425}{100}$

C. $30\frac{17}{40}$

D. $30\frac{425}{100}$

4. Subtract 4 – 0.554

   A. 34.46

   B. 0.3446

   C. 3446

   D. 3.446

5. Add 59.9 + 30.432 + 7.84

   A. 99.654

   B. 98.172

   C. 9.8172

   D. 43

6. Multiply 8.27 × 0.7

   A. 0.5769

   B. 5.769

   C. 0.5789

   D. 5.789

7. Divide 64.48 ÷ 1.04

   A. 58

   B. 62

   C. 59.2

   D. 61.2

8. Complete the table:

Question	**Fraction**	**Decimal**	**Percent**
a			0.8%
b	3/5		
c		3	
d	3/4		
e		.24	
f			65%

9. $\frac{5}{16} + \frac{3}{8} =$
10. $1\frac{1}{3} + \frac{23}{8} =$
11. $\frac{1}{4} - \frac{1}{12} =$
12. $4\frac{1}{8} + 1\frac{2}{3} =$
13. $\frac{9}{10} - \frac{5}{6} =$
14. $3\frac{3}{8} + 2\frac{3}{4} =$
15. $\frac{5}{8} \div \frac{1}{2} =$
16. $12\frac{5}{8} \div 1\frac{1}{4} =$
17. Which is thicker, a $\frac{3}{16}''$ sheet of metal, or a 0.165″ thick sheet.
18. Round 5237.02056 to the nearest thousandth
19. Convert $\frac{17}{32}$ to a decimal. Express your answer to the nearest thousandth.

Answers

1. $\frac{2}{4} = \frac{1}{2}$
2. A) $\frac{18}{30}$
3. C) $30\frac{17}{40}$
4. D) 3.446
5. B) 98.172
6. C) .5789
7. B) 62
8. Table

Question	Fraction	Decimal	Percent
a	8/1000	.008	0.8%
b	3/5	.6	60%
c	3/1	3	300%
d	3/4	.75	75%
e	6/25	.24	24%
f	13/20	.65	65%

9. $\frac{11}{16}$
10. $3\frac{17}{24}$
11. $\frac{1}{6}$
12. $5\frac{19}{24}$
13. $\frac{1}{15}$
14. $6\frac{1}{8}$
15. $1\frac{1}{4}$
16. $10\frac{1}{10}$
17. $\frac{3}{16}$
18. 5237.021
19. 0.531

Reading the Toolbox Blueprint

Scan the ‘Precision Toolbox’ Blueprint (PDF), and locate the following information:

- Project Name ____
- Tolerances ____

- Height of Toolbox box ____________________
- Height of Toolbox with handle ____________________
- Width of Tool Box ____________________
- Length of Tool Box ____________________
- Material Used ____________________
- What are the upper tray hinges made of ____________________
- Size of screw holes on side of toolbox for handles ____________________
- What 2 types of drawings are shown
    - ________________Assembly Drawing
    - ________________ Assembly Drawing
- Type of Sheet Metal used ____________________
- Width of Toolbox Handle ____________________
- Rivets are placed how far from edge ____________________

Plans and Elevations

ACTIVITY

Table 1 FRONT VIEW

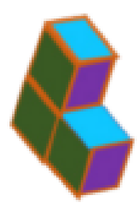
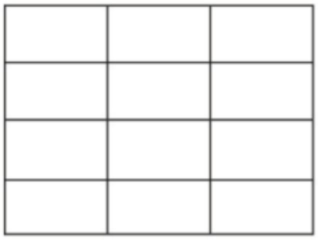
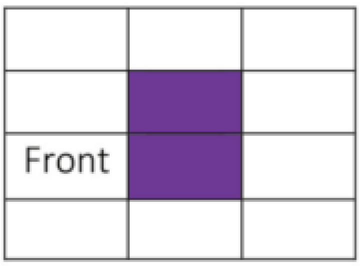


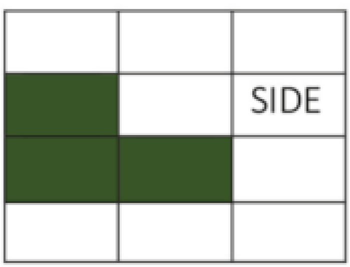
Table 2 SIDE VIEW

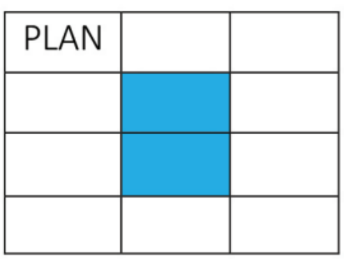
Table 3 PLAN VIEW



Answers







32.

Wall Hanging Project Metal: Reading Blueprint & Hole Layout

How to read the Wall Hanging Project Blueprints

Start with the **title block**. In this case, it is a box along the bottom of the drawing. The scale tells you the relationship in size between the drawing and the actual prod- uct. For example, on a $1:3$ scale, one inch on the drawing means 3 inches on the actual product.

What is the **scale** of this drawing?

The dimensions on the drawing are all in the same unit – for example: inches, feet, millimeters, centimeters, or meters.

What are the **units** used for the dimensions on this drawing?

What perspective and views do you see on the drawings? Page 1: What **perspective** is this?

Page 2: What are the four **views**? What does each of these mean?

The drawing includes the dimensions of the shelf and the layout of the holes. What are the overall **dimensions** of the shelf?

Thickness Width Length

What are the overall **dimensions** of the metal bracket? Thickness

Width Length

Angles are indicated with two lines making a pie shape. What is the **angle** on the shelf?

Look for symbols and abbreviations particular to architectural drawings.

Ø means the diameter of a hole.

What is the diameter of the holes in the shelf?

What is the diameter of the holes in the metal bracket?

Typ. means that all of the dimensions similar to this are the same. How far apart are all the holes on the shelf?

A **dashed line** indicates the centre of something, for example a hole. What is the location of the centre hole on the shelf?

What is the location of the top hole on the metal bracket?

Check the **notes**:

What **hardware** do you need?

Reading the Wall Hanging Blueprint

Find the scale on the Blue print for the Wall Hanging Project:

Scale = __________

Find the measurements on the Blueprint:

Length given on Blueprint of shelf: ____________
Thickness of wood for shelf:________________
Width given on Blueprint of shelf: ____________

Perspective the shelf is drawn in:__________

What degree is the angle cut at:___________

Hole Layout on wood:

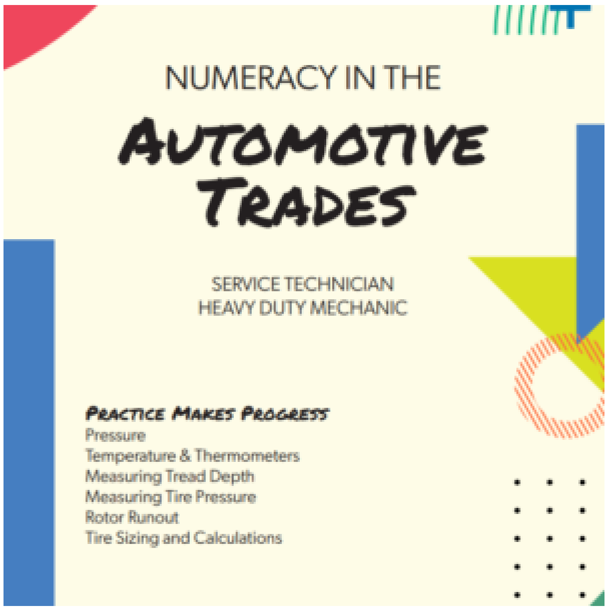
# of Holes: _________
Size of Holes: __________
Center to center of Holes: ___________

Hole Layout on steel:

# of holes_______
Size of Holes________

V

Numeracy in the Automotive Trades



Automotive-Trade Tools

Brake drum gauge

An indispensable instrument for precisely determining the wear condition of the brake drums. It enables fast and simple measurement of the brake drum diameter or the amount of wear.

If air brakes are used, the minimum thickness is 3.2 mm ($\frac{1}{8}$ inch). If hydraulic disc, drum or electric brakes are used, the minimum thickness is 1.6 mm ($\frac{1}{16}$ inch). The maximum allowable brake drum diameter is stamped or cast into the outer edge of the drum. Place a brake drum diameter gauge inside the drum. Take several measurements within 90 degrees of each other at the top and bottom of the inside of the drum's friction surface. nominal diameter: Replace the brake drum.

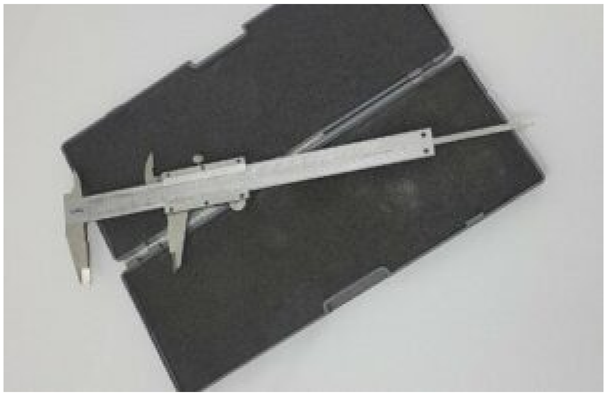
Telescoping gauge

Telescoping gauges are indirect measuring devices used to measure the internal diameter of a bore, hole, groove, slot, etc. This T-shaped tool consists of a handle, two telescopic, spring loaded, plunge rods and a locking screw.

Calipers-Micrometer

Calipers, which come in analog and digital measuring forms, are a must-have instrument for determining the distance between two opposing surfaces of an object. The whole distance can be measured using an integrated ruler by setting the tips of such a caliper to fit all across the object surface, and removing the calipers. Calipers are used in a wide range of professions, including mechanical engineering, science, and medicine, as well as in the field by metalworkers, forestry researchers, and woodworkers.

In many aspects, the design of a micrometer is identical to that of a caliper. A micrometer is used in the same way as a caliper is used. Micrometers are commonly used in machine shops and in the mechanical engineering community. It’s used to determine an object’s length, width, and depth, as well as its thickness.

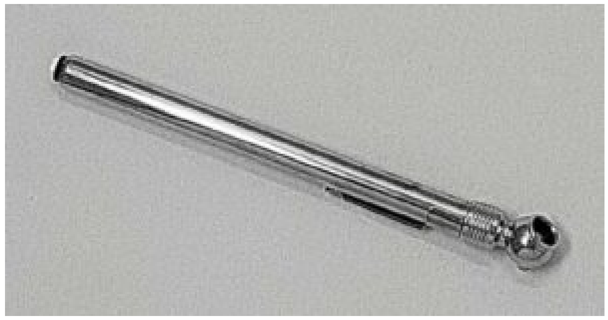


Tread depth gauge

Designed to measure the degree of wear of tire surfaces.

Tire pressure gauge

Used to measure the pressure of the tyres of a car, motorbike or any vehicle that uses inflated tires. Gauges offer accurate and reliable readings and come in both standard or digital formats.



33.

Pressure

Pressure Measurements

Pressure: The force exerted by an object on another object, or the force exerted by an object per unit area. That area could be any area you could come up with, but for the most part we use a square inch or a square metre. When dealing with pressure our starting point is going to be pounds per square inch (psi). Pounds per square inch is the imperial version of pressure, and the one most of us are most likely familiar with. We use this measurement when dealing with things like pumping up car or bike tires, or when dealing with water pressure.

The most common metric version of pressure is known as the Pascal (Pa), and quite often we put Pascals into groups of 1000, so it is then called a kilopascal (kPa). Now, as pressure is defined as force per unit area, we should define what a Pascal actually is. One Pascal is equal to a pressure of one Newton per metre square (n/m2) where a Newton is a measure of force.

Newton: The force needed to move (or accelerate) an object weighing one kilogram at one meter per second squared.

$$1 \text{ psi} = 6.895 \text{ kilopascals}$$

$$\frac{1 \text{ psi}}{10 \text{ psi}} = \frac{6.895 \text{ kPa}}{(X) \text{ kPa}}$$

$$1 \times (X) = 10 \times 6.895$$

$$(X) = 68.95$$

Answer = 68.95 kPa

One pound per square inch equals: 6.895 kilopascals (kPa)

Air pressure at different Altitudes:

- Sea level – 14.7 psi
- 10,000 feet – 10.2 psi
- 20,000 feet – 6.4 psi
- 30,000 feet – 4.3 psi
- 40,000 feet – 2.7 psi
- 50,000 feet – 1.6 psi

To check the reading on the tire pressure gauge, simply **read the slide ruler for manual pen gauges, the dial for dial pressure gauges, or the digital screen for digital pressure gauges.** The ruler, dial, or screen should display the current tire pressure in PSI.

Understanding Pressure

Let's say you take a 1-inch by 1-inch piece of wood that's 3 feet long, and let's say this piece of wood weighs 1 pound. If you were to stand that piece of wood on-end on your foot, it would place 1 pound of force on your toe.

Since its cross-section is 1 square inch, it exerts 1 pound per square inch of force (1 psi) on your toe.

If you were to take a 30-foot-long piece of the same wood and balance it on your foot, it would apply 10 psi of pressure.

If it were 300 feet long, it would apply 100 psi, and so on.

Water that is 1 foot deep exerts 0.43 psi, so if you are a mile underwater there's about 2,270 psi being exerted. That is, a 1-inch-square column of water a mile high weighs 2,270 pounds.

Air works the same way. The atmosphere is about 50 miles "deep," and at sea level it exerts 14.7 psi. That is, a 1-inch-square column of air 50 miles high weighs 14.7 pounds. Our bodies think 14.7 psi of air pressure is completely normal.

Exerting Pressure

For every 10° fluctuation in air temperature, vehicle tire pressure will vary by about 1 psi. The way a gas exerts pressure inside a container like a tire or a balloon is through the action of the air atoms colliding with the sides of their container. Imagine that you have a single atom of nitrogen in a sealed container. That atom is in constant motion ricocheting off the sides of the container. The speed of the atom's motion is controlled by the temperature. At 0 degrees Kelvin (absolute zero) the atom has no motion, and at higher temperatures the speed increases.

By its collisions with the sides of the container, the atom exerts an outward pressure. So there are two ways to increase the pressure inside the container:

- Raise the temperature of the atoms inside the container – The hotter the atoms, the faster they move.
- Put more atoms in the container – The more gas atoms you put in the container, the more collisions you get and the greater the pressure they exert on the sides of the container.

When you blow up a tire on a car or a bike, use a pump to increase the pressure of the air inside the tire by increasing the number of atoms inside the tire. A car tire typically runs at 30 psi, and a bike tire might run at 60 to 100 psi. There is no magic here — the pump simply stuffs more air into a constant volume, so the pressure rises.

Absolute Pressure

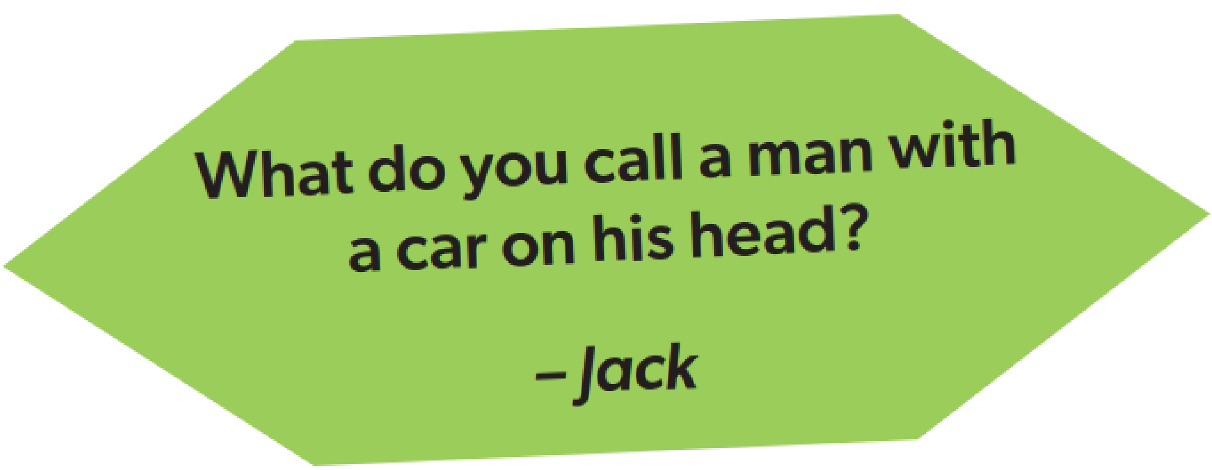
Absolute pressure is the sum of gauge pressure and atmospheric pressure.

Gauge Pressure + Atmospheric Pressure = Absolute Pressure

Atmospheric Pressure is a unit of pressure defined as equivalent to 14.696 PSI (Pounds per square inch).

If your tire gauge reads 34 psi (pounds per square inch), then the absolute pressure is 34 psi plus 14.7 psi (atm in psi), or 48.7 psi (equivalent to 336 kPa).

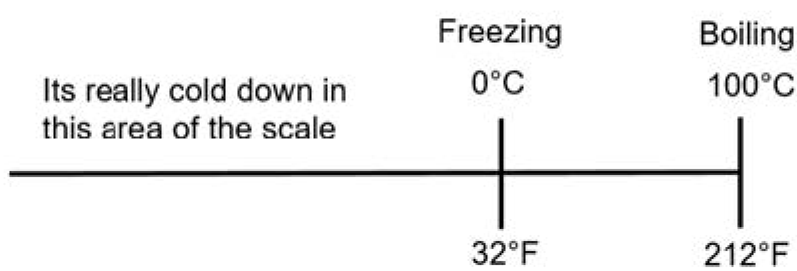
Pounds per square inch (psi)	Kilopascals (kpa)	Rounded
0.01	0.07	
0.1	0.69	.7
1	6.89	7
2	13.79	14
3	20.68	21
5	34.47	35
10	68.95	69
20	137.9	138
50	344.74	345
100	689.48	690
1000	6894.76	6895



34.

Measuring Temperature

- Room temperature
    - Metric is 20° Celsius
    - Imperial is 68° Fahrenheit
- Water boils
    - Metric is 100°C
    - Imperial is 212°F
- Water freezes
    - Metric is 0°C
    - Imperial is 32°F



When converting from Celsius to Fahrenheit, multiply the degrees in Celsius by 1.8, then add 32.

$$°\text{Fahrenheit} = °\text{Celsius} \times 1.8 + 32$$

When converting from Fahrenheit to Celsius, subtract 32 from the degrees in Fahrenheit, then divide the difference by 1.8.

$$°\text{Celsius} = °\text{Fahrenheit} - 32 \div 1.8$$

35.

The Thermometer

“How hot?” “How cold?”

The thermometer is here to tell you!

Measured in degrees, with two scales: Fahrenheit and Celsius

Types of Thermometers

Infrared

- non-contact measurement
- extremely high or low surface temperatures
- laser targeting system
- automotive trade and air conditioning systems
- Important: laser spot-size and the emissivity value of the surface being measured

K-type thermometers

- Fixed and Wired Probes
- ability to facilitate a range of interchangeable plug in probes
- air, liquid, penetration and surface probes
- vary in size, material, and maneuverability

Thermal Imaging Cameras

Thermal imaging cameras have a variety of uses such as surveying buildings to find moisture and leaks. They can also identify energy loss and poor insulation and electrical faults. Ideal for detecting hidden problems.

Traditional Thermometers

- At home measurement of Air and Water
- They consist of a narrow, sealed glass tube with a bulb filled with mercury, alcohol (usually dyed red, to make it easily visible), or some other liquid at its lower end

Food Thermometers

- Dial Oven-Safe (Bimetal)
- Digital Instant-Read (Thermistor)
- (continued in Culinary…)

36.

Gauges Found in Motor Vehicles

- Speedometer
- Fuel Gauge
- Temperature Gauge or Warning Lamp
- Tachometer
- Oil Pressure Gauge or Warning Lamp
- Charging System Gauge or Warning Lamp

The two most common gauges found on your dashboard are the speedometer and the fuel gauge, the others that may be included are: temperature gauge, tachometer, voltmeter and oil pressure gauge. If some of the later do not appear on the dashboard, then a warning light will appear if needed, with the appropriate signage for instruction.

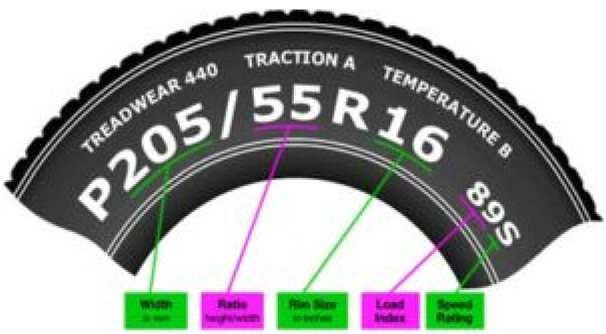
Gauges Used on Motor Vehicles

- Feeler Gauge blades
- Tread Depth Gauge
- Tire Pressure Gauge

(The last two- tread depth and tire pressure- are gone over in detail in this Automotive section, with hands on activities for them.)

37.

Tire Sizes and Calculations (by Patrick Jones)



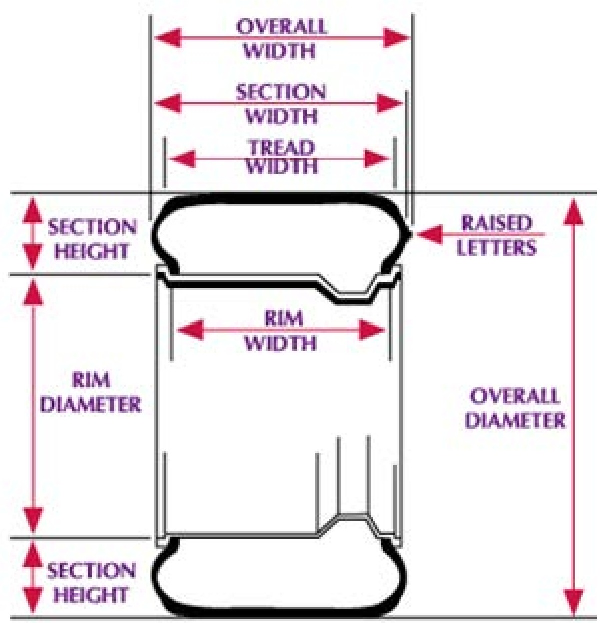
The tire size branded on the sidewall indicates dimensions, construction, speed and load ratings and durability.

Our example will be based on the 205/55R16 size.

The letter P indicates the tire is for a Passenger car and is not related to tire size.

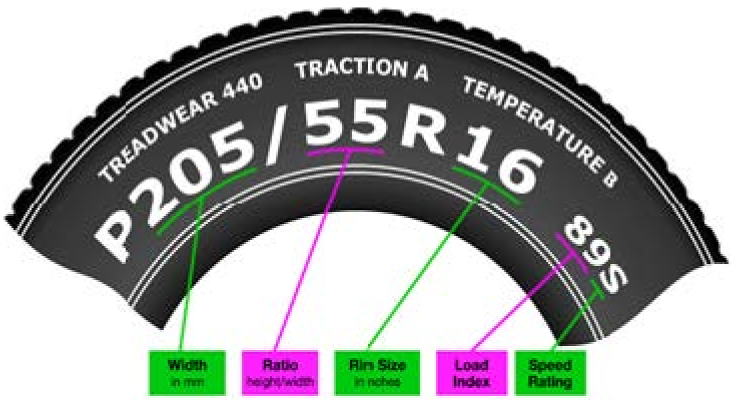
205 identifies the tire's "Section Width" (cross section) in millimeters.

P**205**/55R16 89S – The **205** indicates this tire is 205 millimeters across from the widest point of its outer sidewall to the widest point of its inner sidewall when mounted and measured on a specified width wheel. Because many people think of measurements in inches, the 205mm can be converted to inches by dividing the section width in millimeters by 25.4 (the number of millimeters per inch). E.G. = 205 mm ÷ 25.4 = **8.07″**



Sidewall Aspect Ratio Following the three digits identifying the tire's Section Width in millimeters is a two-digit number that identifies the tire's profile or aspect ratio. This is the sidewall height as a percentage of width.

P205/**55**R16 89S **The 55 indicates that this tire's sidewall height (from rim to tread) is 55% of its section width**: 205 mm × .55 = 112.75 mm. The measurement is the tire's section height, and also referred to as the **tire's series, profile or aspect ratio**. The higher the number, the taller the sidewall; the lower the number, the lower the sidewall. **We know that this tire size's section width is 205 mm and that its section height is 55% of 205 mm, by converting the 205 mm to inches (205 mm ÷ 25.4 = 8.07″) and multiplying it by 55% (.55) we confirm that this tire size results in a tire section height of 4.43″.** If this tire were a P205/70R16 size, our calculation would be: 8.07″ × 0.70, resulting in a section height of 5.69″, approximately a 1.3″ taller sidewall.



The Letter R following the 55 indicates Radial type Construction and is not related to tires size.
Tire and Wheel Diameter:

P225/50R16 89S- The 16 indicates the wheel rim diameter in inches that the tire is designed to be mounted on. So it would be mounted on a 16″ wheel. To determine overall tire diameter, we would add the rim diameter to the previously calculated section height × 2:

> 16″ + (4.43″ × 2) = 24.86″
> or: 16″ + 4.43″ + 4.43″ = 24.86″ overall diameter

To determine the circumference of the tire and wheel assembly we would use the following calculation. Overall diameter × 3.14 (3.14 represents pi, which is a defined formula used to measure circular objects). The circumference of our example assembly would be:

> 24.86″ × 3.14 = 78.06″ (this is the distance the tire will travel in one revolution.)

Using the learned information and formulas, find two different size tires in the shop and complete the in the activity section chart

(Tire # 1 is shown as our example):

Remember the calculations:

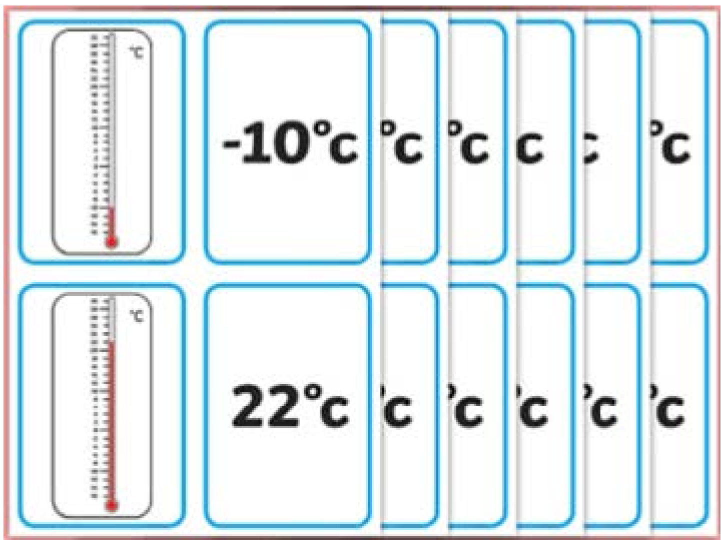
Overall diameter: 16″ + (4.43″ × 2) = 24.86″

38.

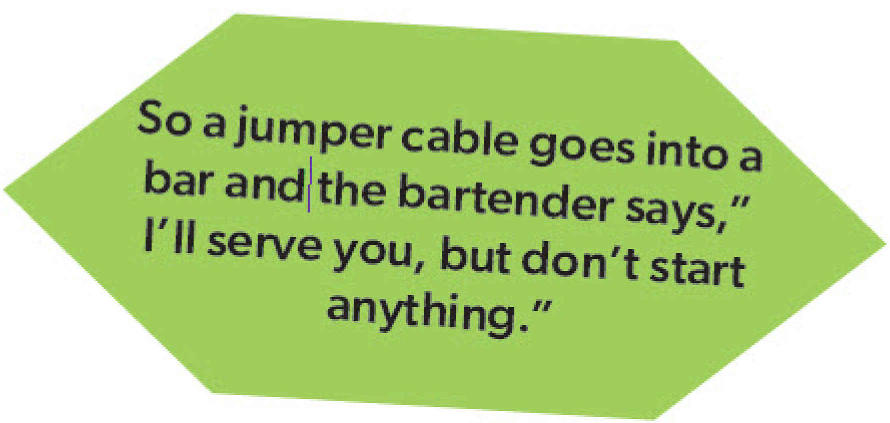
Activities

Thermometer Game Idea

ACTIVITY



- Create cards of different measurement markings shown on a thermometer.
- Create anther deck of cards with just the written temperatures on them.
- Mix and match the cards with your friends to practice reading thermometers!



Tread Depth

ACTIVITY

What do tread depth numbers mean?

The tire tread depth gauge measures in 32nds of an inch. A good tire tread depth is $\frac{6}{32}$ or deeper. If the depth is $\frac{4}{32}$, its time to consider replacing your tires for new ones. $\frac{2}{32}$ or less means that you should change your tires ASAP. A legal winter tire must have $\frac{3}{32}$ of tread depth. Regular tread depth checks help avoid sliding and skidding on the roads while braking.

Checking your tire tread depth:

1. Park and turn off your car. Ensure the emergency brake is on.
2. Grab the depth gauge, find the pin, and insert it into the grooves between the treads of the tire. Press down on the base plate of the gauge unit until it's flush with the tire tread.
3. Repeat step 2 in at least 4 different places on each tire for an accurate read.
4. The lowest reading you get is going to be the correct overall reading for the tire. If the reading fluctuates across multiple points on the same tire, your tires need to be replaced.
5. Find out what those readings mean:

Tread Depth	**What to do**	**Impact to Braking Distance**
$\frac{5}{32}''$ or more	Nothing	Minimal
$\frac{3}{32}''$ to $\frac{4}{32}''$	Consider replacing	Significant
$\frac{2}{32}''$ or less	Replace immediately	Very significant

6. If you don't have a depth gauge, another quick way to measure your tires is with a Canadian nickel. Insert the coin with Queen Elizabeth's crown facing down. If you can see the top of the Queen's crown, your tire is below $\frac{2}{32}''$.

Understanding Temperature

ACTIVITY

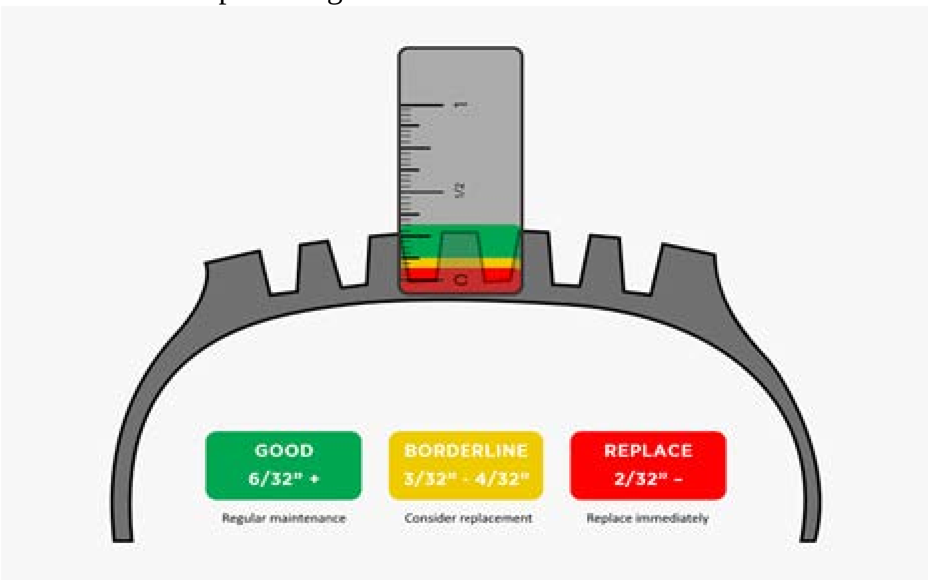
Remember:

°C to °F Divide by 5, then multiply by 9, then add 32
°F to °C Deduct 32, then multiply by 5, then divide by 9

1. Fill in the blanks

°C	°F	
180		Moderate oven
100		Water boils
40		Hot bath
37		Body temperature
	86	Beach weather
	70	Room temperature
	50	Cool day
	32	Freezing point of water
	0	Very cold day
	−40	Extremely cold day (and the same number)

2. Convert these to percentages



Answers

1.

°C	**°F**	
180	360	Moderate oven
100	212	Water boils
40	104	Hot bath
37	98.6	Body temperature
30	86	Beach weather
21	70	Room temperature
10	50	Cool day
0	32	Freezing point of water
−18	0	Very cold day
−40	−40	Extremely cold day (and the same number)

2. Percentages
    1. $\frac{6}{32}$ in percent $= 6 \div 32 = .1875 \times 100 = 18.75\%$
    2. $\frac{3}{32}$ in percent $= 3 \div 32 = .09375 \times 100 = 9.375\%$
    3. $\frac{4}{32}$ in percent $= 4 \div 32 = .125 \times 100 = 12.5\%$
    4. $\frac{2}{32}$ in percent $= 2 \div 32 = .0625 \times 100 = 6.25\%$

Tire Scavenger Hunt

ACTIVITY

Using your tire Pressure Gauge, and Tread Depth Gauge, find these measurements on the tires of family, friends, or your own vehicles. Check back on the information given to properly get a reading of how much air is in the tires, and how much wear they have left on them.

1. Locate lowest tread depth and determine if it is below required specifications. Pick either mm or fractions and do the conversions.
   What percentage of tire life is left?
   Do the conversions below. (1 PSI = 6.895 KpA)

Tread Depth	Pressure

mm	fraction	Psi	kPa

2. Inspect the markings on your tires and fill out the chart below.

	Tire #1	Tire #2	Tire #3
Size marked	205/55R16		
Width	205 mm		
Aspect ratio	55		
Section height	4.43″		
Rim diameter	16″		
Overall diameter	24.86″		
Circumference	78.06″		

3. If tire pressure drops 1 psi every 10 degrees, and you set it to 32 psi on a 25 degree day, what would the psi be at in the winter with a temperature of 0 degrees?
4. What is the temperature today? Based on the psi of the tires above, what will their psi be when the temperature drops to negative?

Measuring Brake Rotors

Brake Rotor Thickness: Can it be used? Know Minimum Thickness – Read Stamped Rotor

In order to get an accurate measurement for the amount of brake rotor wear we depend on our trusty micrometer. Prepare your car so you can remove the wheel.

Next, you simply measure the thickness in at least three different spots of the brake rotor. Make sure to write down your measurements, you may get small variations. It helps to get at least 4-5 different measurements and to take the average of that.

Next, take a look at the brake rotor center hat. This is the portion that doesn't get exposed to the brake pad. You will normally find your minimum rotor thickness stamped there. It may be faint, but it's usually there. In some cases it may be located on the outer edge of the rotor.

Wall Hanging Project

The exact purpose of a gasket is to prevent fluids, liquids or gases, from escaping or entering, even at extreme pressures and temperatures.

A gasket tightens the joint with bonding and padding material between two surfaces.

In various parts of the engine, there are many different gaskets that are used. Their primary duty is to prevent debris from entering the engine, to maintain constant internal pressure, and to keep within the engine oil and other fluids.

A gasket is just one suggestion of holding your vial in place for your Wall Hanging Shelf.

DID YOU KNOW?

Every winter, approximately 4.9 million tonnes of salt is applied to Canadian roads

VI

Numeracy in Culinary Arts & Horticulture

Measuring Tools

Measuring cups

Dry measuring cups come in varying sizes such as $\frac{1}{4}$ cups, $\frac{1}{3}$ cups, $\frac{1}{2}$ cups, or 1 cup. Simply scoop, and level off excess ingredients with a flat object. This in known as the "Dip and Sweep." Measuring spoons come in smaller portions of $\frac{1}{4}$, $\frac{1}{2}$ etc in teaspoons and tablespoons. Liquid cannot be measured the same way as dry ingredients, so we measure wet ingredients with a liquid measuring cup. Place on flat surface you can view at eye level for accuracy.

Scales

For the most accuracy, while preparing food and measuring ingredients, a scale is your best bet.

- **Mechanical Scale**: place ingredients you wish to weigh on the bowl-like plate, and the hand will move accordingly, pointing to the designated weight reading.
- **Digital Scale**: provides ultimate accuracy.
- **Hanging Scales**: come with a hook on the bottom, often used for heavy items like fish and meat.

Thermometers

- **Digital Thermometers** deliver accurate readings of internal temperatures of food. This is especially crucial for cooking meats, as undercooked meat can sometimes be harmful.
- **Instant Read Digital Thermometers** have a sensor that will stop when the precise, accurate, current temperature is reached.
- **Oven Thermometers** stay in the item being cooked while cooking, making it great for consistency. You are able to continuously see the internal temperature as it is being cooked.

39.

Measuring Conversions

Culinary math begins with the basics of addition, subtraction, multiplication, and division along with ratios, yields, and percentages. Ingredients must be measured and scaled accurately, food production quantities are calculated, and recipes are increased or decreased to scale based on demand.

Temperature

Sometimes, a recipe might provide cooking temperatures in Celsius, but the dial on your range displays Fahrenheit, and vice versa. If you know the formula to convert Celsius to Fahrenheit you can easily figure out what to set your dial to.

The formula is °F = ((9 ÷ 5) × °C) + 32. For example, if the Celsius temperature is 200, you convert it to Fahrenheit by working out ((9 ÷ 5) × 200) + 32, i.e. 360 + 32, which is 392 degrees Fahrenheit. To convert a temperature of 392 degrees Fahrenheit to Celsius, the calculation is (392 − 32) ÷ (9 ÷ 5).

Quantities

If you want to make more than one batch, you need bigger quantities of every ingredient. Multiply each ingredient by the number of batches. For example, if a recipe provides an ingredient list for six cookies but you want to make 12 cookies, you need to multiply all ingredients by two to make your larger batch. That may involve multiplying fractions, for example if the recipe calls for $\frac{2}{3}$ cup of milk, and you need to double it, the formula is $2 \times \frac{2}{3} = \frac{4}{3} = 1\frac{1}{3}$.

A knowledge of fractions is also useful if you want to make a smaller batch than the recipe. For example, if the recipe provides an ingredient list for 24 cookies, but you only want to make six cookies. In this case, you need to quarter each ingredient. So if the recipe requires two teaspoons of baking powder, you only need $\frac{1}{2}$ a teaspoon because $2 \div 4 = \frac{1}{2}$.

Cooking Time and Weight

You often have to work out how long to cook something based on its weight, such as a turkey for Thanksgiving dinner. First, you may need to thaw that turkey. If a turkey has to thaw in the refrigerator for 24 hours per 5 pounds, how long do you need to thaw a 10-pound turkey? To work this out, you take the weight of the turkey and multiply it by the time value you already have, i.e. 10 × 24. Next, you divide this figure (240) by 5 pounds. The answer (48) is the number of hours you have to thaw a 10-pound turkey. To work out how long you have to cook something, the formula is cooking time in minutes = 15 + ((mass in grams ÷ 500) × 25). For example, if you have a chicken that weighs 2.8 kg, the calculation is 15 + ((2800 ÷ 500) × 25). The answer is 155 minutes, meaning you have to cook the chicken for 2 hours and 35 minutes.

Converting Cups to Pounds

Converting measurements is often necessary when you are involved in cooking. Measuring ingredients can require that liquids be converted from one unit of measure to another. A liquid such as water, for example, may need to be converted to ounces or pounds before being mixed. This can at first seem a daunting task, however, when the problem is approached from a point where basic equivalents are considered, then the problem may be more easily worked and the conversion made.

Begin converting cups to pounds by understanding a few basic conversion points. 16 ounces equals one pound or two cups. Another way to look at the equivalent is that one cup weighs eight ounces and therefore two cups equal 16 ounces and this is the same weight of one pound–16 ounces.

Convert a cup measurement to pounds by applying the formula in step one to the problem. For example, if you are converting five cups to pounds you will first multiply five (the number of cups) by eight (the number of ounces in one cup). The answer here is 40.

Divide the number 40 by 16 or the number of ounces in one pound. So, in the example, 40 divided by 16 equals two and one half. The answer is five cups weighs 2.5 pounds. Another way to look at the problem is that for every one pound you must have two cups.

Converting Grams to Ounces and Pounds

You can convert grams to ounces and/or pounds just by using some simple multiplication and division. You'll use the conversion that tell you there are 0.035 oz. in a gram and 16 oz. in a pound. If you want to do calculations that tell you how to convert grams to pounds, skipping over ounces, you'll use the conversion that tells you there are 0.00220462262 lb. in a gram. Although a calculator will expedite how quickly and how correctly you can convert your grams to ounces and/or pounds, you can also do so with a pencil and paper.

Multiply your number of grams by 0.0352739619. The answer will tell you how many ounces you have. For example, 1,000 g times 0.0352739619 oz. equals 35.2739619 oz.

Divide your ounces from step 1 by 16. The answer will tell you how many pounds you have. Your remainder will tell you how many ounces are left over if there aren't enough to make a full pound. For example, 35.2739619 oz. divided by 16 equals 2 with a remainder of 3.2, so you have 2 lbs., 3 oz.

Multiply your number of grams by 0.0625 pounds if you want to convert grams directly to pounds without considering or having to do calculations for ounces. For example, 1,000 g times 0.00220462262 lb. equals 2.20462262 lbs.

Ratio Review for Recipes

Example: A Recipe for pancakes uses 3 cups of flour and 2 cups of milk.

So the ratio of flour to milk is $3 : 2$

To make pancakes for a LOT of people we might need 4 times the quantity, so we multiply the numbers by 4:

$$3 \times 4 : 2 \times 4 = 12 : 8$$

In other words, 12 cups of flour and 8 cups of milk.

The ratio is still the same, so the pancakes should be just as yummy.

Metric

Unit	**Multiplier**
kilogram (kg)	1000
gram (base unit) (g)	1
milligram (mg)	0.001

Imperial

Unit	**Multiplier**
ounce (oz)	$\frac{1}{16}$ or 0.0625 pounds
pound (lb)	16 ounces
ton	2000 pounds

40.

Soluble Solutions Ratios

Often we express the concentration of a diluted solution in terms of ratio to the original. A $1:10$ ratio, for example, meaning that the final solution has been diluted tenfold. Don't let this intimidate you; it's just a different form of a simple equation. You, too, can calculate ratios between solutions. Here's how to set about solving these kinds of problems.

Determine what information you have and what you need to find. You might have a solution of known starting concentration and be asked to dilute it by some set ratio — $1:10$, for example. Or you might have the concentration of two solutions and need to determine the ratio between them.

If you have a ratio, convert it into a fraction. $1:10$ becomes $\frac{1}{10}$, for example, while $1:5$ becomes $\frac{1}{5}$. Multiply this ratio by the original concentration to determine concentration of the final solution.

Use the fraction to determine how much of the original solution should be added to a given volume when diluting.

If you need to find the ratio of concentration between two solutions, just turn it into a fraction by placing the original solution in the denominator and the dilute solution in the numerator.

Next, multiply or divide both numerator and denominator of the fraction by the smallest number that will convert them to a whole-number ratio. The whole goal here is to get rid of any decimal places in numerator or denominator.

Change the fraction back into a ratio.

What do you get if you divide the circumference of a pumpkin by its diameter?

– Pumpkin Pi

41.

Understanding Percentages

Now that we understand fractions and ratios, lets take a look at percentages.

A percentage is a ratio that can be expressed as a fraction of 100. “Per” “cent” means “part of 100” (*cent* is Latin for 100). If we need to know the percent of a number, we simply divide by 100.

The symbol used for percent is %.

What is 40% of 80? Ways to achieve:

- 0.40 × 80 = 32
- 40 × 80 ÷ 100 = 32

Percent as a fraction:

- 10% is equal to $\frac{1}{10}$ fraction
- 20% is equivalent to $\frac{1}{5}$ fraction
- 25% is equivalent to $\frac{1}{4}$ fraction
- 50% is equivalent to $\frac{1}{2}$ fraction
- 75% is equivalent to $\frac{3}{4}$ fraction
- 90% is equivalent to $\frac{9}{10}$ fraction

Example

A recipe for pancakes uses 3 cups of flour and 2 cups of milk.

So the ratio of flour to milk is $3:2$.

To make pancakes for a lot of people, we might need 4 times the quantity, so we multiply the numbers by 4:

$$3 \times 4 : 2 \times 4 = 12 : 8$$

In other words, 12 cups of flour and 8 cups of milk.

The ratio is still the same, so the pancakes should be just as yummy.

DID YOU KNOW?

Bakers Dozen

Baker's dozen means 13, instead of 12. The tale behind its origin is that a medieval law specified the weight of bread loaves, and any baker who supplied less to a customer was in for dire punishment. So bakers would include a thirteenth loaf with each dozen just to be safe

Q: What do you call a teapot of boiling water on top of mount Everest?

A: A high-pot-in-use

42.

Conversion Charts (Chef Kate's Kitchen Math)

Go-to Cooking Conversions

Dry Measurement Conversions

Teaspoons (tsp)	Tablespoons (tbsp)	Cups (c)
3 tsp	1 tbsp	$\frac{1}{16}$ c
6 tsp	2 tbsp	$\frac{1}{8}$ c
12 tsp	4 tbsp	$\frac{1}{4}$ c
24 tsp	8 tbsp	$\frac{1}{2}$ c
36 tsp	12 tbsp	$\frac{3}{4}$ c
48 tsp	16 tbsp	1 c

Liquid Measurements (Volume)

Metric	Standard
1 milliliter (mL)	$\frac{1}{5}$ tsp
5 mL	1 tsp
15 mL	1 tbsp
240 mL	1 cup (8 fluid ounces(fl. oz))
1 liter	34 fl. oz

Dry Measurements (Weight)

Metric	Standard
1 gram (g)	.035 oz
100 g	3.5 oz
500 g	17.7 oz (1.1 pound)
1 kilogram (kg)	35 oz

Imperial to Metric Cooking Conversions

Standard	Metric
$\frac{1}{5}$ tsp	1 mL
1 tsp	5 mL
1 tbsp	15 mL
1 fl. oz	30 mL
1 c	237 mL
1 pint (pt)	473 mL
1 quart (qt)	.95 l
1 gallon (gal)	3.8 l
1 oz	28 grams (gr)
1 pound (lb)	454 gr

Quick and Common Weights

Measurement/Ingredient	Grams
1 c. all-purpose flour	127 g
1 c. granulated sugar	200 g
1 c. unsifted powdered sugar	125 g
1 c. packed brown sugar	220 g
1 c. rolled oats	85 g
1 c. vegetable oil	218 g
1 c. milk	227 g
1 c. heavy cream	238 g
1 c. butter	227 g
1 large egg (white and yolk)	48 g

43.

Activities

Temperature Review

Converting Fahrenheit to Celsius in the Kitchen

ACTIVITY

Recall:

Convert degrees from Fahrenheit (F) to Celsius (C):

- Subtract 32 from the Fahrenheit temperature, multiply by 5, then divide by 9.

If the temperature is 350 °F, you would subtract 32 to get 318, then multiply by 5 for 1,590 which divided by 9 equals 176.66. That is then rounded up to 180 °C.

Fill in the blanks

ACTIVITY

(Degrees) Celsius	(Degrees) Fahrenheit
	250 °F
160 °C	
	350 °F
205 °C	
	425 °F

ANSWERS

Degrees (Celsius)	Degrees (Fahrenheit)
120 C	250 F
160 C	320 F
180 C	350 F
205 C	400 F
220 C	425 F

Using a Scale (by Wendy Okopski)

ACTIVITY

We often encounter recipes at home that are measured by cups. In industry, the recipes are usually in grams/kilograms or ml/L. Generally, the volume of 1 cup is equal to 250ml and is easily converted. Let's say you need to multiply a home style recipe from 1 recipe to 4x the recipe to adapt to an industry setting.

- If the recipe calls for 1 cup, multiply 4 × 250ml = 1 L of liquid.
- If the recipe calls for 2 cups multiply 2 × 250ml = 500 ml of liquid.

For weighed ingredients, it is important to remember that different items will weigh more than others. Experiment to see how each item differs in weight.

Remember to weigh the empty cup first, and tare the scale to get an accurate weight. Level each ingredient carefully.

	Salt	**Water**	**Flour**
1 cup			
$\frac{1}{2}$ **cup**			
$\frac{1}{4}$ **cup**			

If you need to convert a home style recipe from 1 cup of flour to a recipe that needs 1.2 kg of flour, you will need to know how much 1 cup of flour weighs in order to make that calculation.

- 1 cup of flour = 150g
- 1.2kg of flour = 1200g

- $1200 \div 150 = 8$

You would need to multiply the flour in your recipe × 8

44.

Introduction to Horticulture

Horticulture is the art or practice of garden cultivation and management. Horticulture involves cultivating, growing and marketing produce. This requires an understanding of numeracy, measurements and geometry. An example would be calculating spacing, and how much to purchase.

Measuring tools in horticulture are very similar to culinary measuring tools, but of course used very differently. Similar tools used are: scales, measuring cups, and thermometers.

Here are some different tools used specifically for horticulture:

- **Fruit Sizing Caliper** – allows grower to assess the fruits health and yield estimation.
- **Rain Gauge** – measures the amount of precipitation in a certain area over a certain amount of time.
- **Hand Refractometer** – A refractometer allows you to accurately measure the percentage of sugar or Brix in any liquid with just 2 or 3 drops. The higher the Brix%, the sweeter the fruit or concentration is. Brix levels are a measurement of plant sugars, mineral and vitamin content.
- **Tree Caliper** – used to measure the 'breast height' (approx. 4.5 feet) diameter of a tree. This helps a horticulturist understand information needed for crown competition, stocking levels, and forest health.

DID YOU KNOW?

China

China has the highest Production of horticulture – China has only 10% of arable land worldwide and produces a quarter of the global grain output. China leads the agriculture production of fruit, vegetables, cereals, cotton, eggs and poultry.

45.

Activities

Building a Yard: Drafting and Budgeting

Introduction

The following pages are a ‘choose your own adventure’ to build a yard. The yard can have gardens, patios and other added features.

Here is how you calculate space:

Your yard will be made up of four parts:

- **Total Space** = (How much space would you like your garden to have? Measure in cubic yards or cubic feet.)
- **No Grass Space/Garden Space** = (How much space in your yard would you like to be used as a garden? How many gardens would you like? Add each garden space together)
- **Patio Space** = (How big would you like your patio to be?)
- **Added Features**: (What would you like to add to your yard example: rocks, flowers, shrubs- these items do not affect the space calculation, as they will be placed on top of the grass, patio or gardens.)

Space-Takers

- 46-inch Recycled Wood and Metal Rectangle Planter, $149.00, 2 ft × 2 ft

- Large Polyethylene Landscape Rock, 42”W × 17”D × 13”H, $159.00

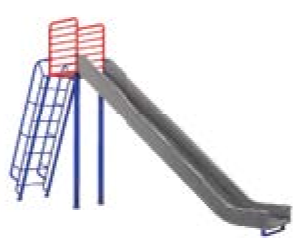
- Grass Sod, 500 sq ft, $495.00

- Aucuba Japonica Shrub, 17.98- 1 ft X 5 ft

- Planter in Slate, $87.98 – 2.5 ft X 2.5 ft

- Tierra Verde, 28-inch, $3250

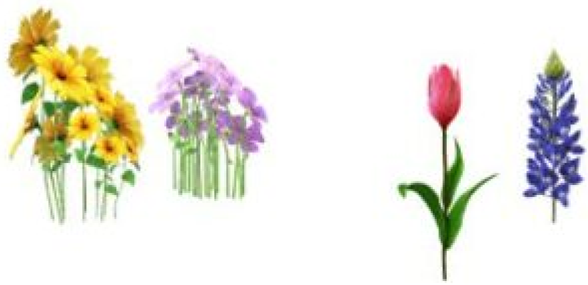
- 4’ freestanding slide 4, $877.00



Added Features

- Garden Arch Arbor for Decorative Climbing Plants $384.00

- Mixed Flower Seed Collection (10-Pack), $22.98



- Cedar, $39.98 ea

- 2 Gallon Elijah Blue Fescue Grass (Festuca), $18.98

- Viagrow 70/30, Coco Perlite, 50 Liter

Patio

- Monterey 12 ft. × 16 ft. Oval Gazebo, $6,299.00

- Patio Round 12 Inch Gray, $6.84

- Genesis Slab, 16×16 Rockland Black, $9.68

Budget Sheet

Space	**Dollar Amount**
Total Space	
No Grass Space/Garden Space	
Patio Space	
Grass Needed (Total space, minus Garden space, minus Patio space)	
Added Features	

Soil = Volume of bed × Number of beds

Soil = Length × Width × Depth × Number of beds

Divide the answer by 27 to get the number of cubic yards, 1 cubic yard = 27 cubic feet

Liters to Cubic Feet formula $ft^3 = L * 0.035315$

Amount of Soil Needed	**Dollar Amount**

Budget sheet continued

Total dollar amount = ____

Tax 15% = ____

If you spend 2500.00 you get a 20% discount

If you spend 4250.00 you get a 30% discount

Discount = _____ % = ____

Calculate & create your yard using [Yard Width To Yard Length PDF](). Print and Design!

46.

Wall Hanging Project Culinary & Horticulture: 5% Saline Solution, Halophytes

Halophyte Grasses and Flowers

Halophytes are plants that can grow in salty habitats, such as coastal regions, mangroves, and saline deserts.

They have special adaptations to cope with high salt concentrations, such as succulent stems, small or no leaves, and salt glands.

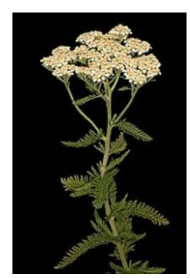
Halophytes are classified into four types based on their salt tolerance and accumulation: euhalophytes, crynohalophytes, glycohalophytes, and halophytes sensu stricto.

Halophytes are important for biodiversity, ecosystem services, and land reclamation. They provide food, fodder, fuel, and medicine for humans and animals.

Halophytes are also potential sources of bioenergy, oil, and protein. They can be cultivated on marginal lands and use saline water for irrigation.

Here are a few halophyte options:

Yarrow



Achillea millefolium, commonly known as **yarrow** (/jæro/) or **common yarrow**, is a flowering plant in the family **Asteraceae**. Other common names include old man's pepper, devil's nettle, sanguinary, milfoil, soldier's woundwort, and thousand seal.

Fool's Onion

Trifolium wormskioldii is a species of clover[1] native to the western half of North America. Its common names include cows clover,[2] coast clover, sand clover, seaside clover, springbank clover,[3] and Wormskjold's clover

Cow's Clover

Triteleia hyacinthina is a species of flowering plant known by the common names white brodiaea,[2] white tripletlily, hyacinth brodiaea, and fool's onion. It is native to western North America from British Columbia to Idaho to central California

How to make a 5% saline solution with salt

A salt solution, also called a saline solution, is simply a mixture of salt and water. Salt is the solute (the dissolving substance), and water is the solvent (the substance that dissolves another to create a solution). To make a salt solution by weight percent (w/v), you apply the formula w/v = (mass of solute ÷ volume of solution) × 100. The density of water is 1 gram per milliliter (g/ml) which means 1 milliliter of water weighs 1 gram.

Work out how much salt solution you need. For this example, say you need 200 ml of salt solution.

Work out 5 percent of 200 (0.05 × 200 = 10). To make a 10 percent salt solution, work out 10 percent of 200 and so on. You can also work this out by re-arranging the formula, but multiplying the final volume by the decimal form of the percentage is simpler.

Weigh 10 grams of salt. You can use any type of salt, including table salt.

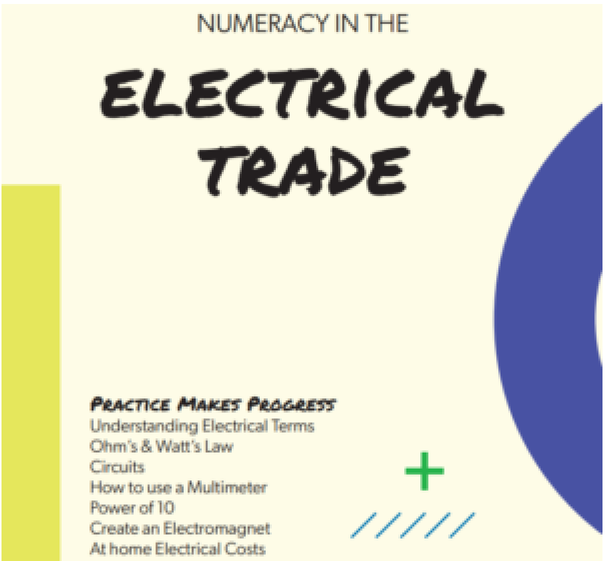
Pour the salt into a graduated cylinder or volumetric flask containing about 180 ml of water. Swirl the flask gently until all the salt dissolves.

Add enough water to bring the final volume up to 200 ml. Don't simply measure 200 ml of water and add 10 g of salt. Adding salt changes the final volume of the solution and affects the final percentage.

The saline solution is to be put into a spray bottle which acts like an ocean spray on the halophytes.

VII

Numeracy in Electrical



47.

Electrical Terminology

Voltage

Voltage is the pressure from an electrical circuit's power source that pushes charged electrons (current) through a conducting loop, enabling them to do work such as illuminating a light.

Voltage = pressure, and it's measured in volts (V).

Current

Current is the flow of electricity in an electronic circuit, and the amount of electricity flowing through a circuit. An electric current is a stream of charged particles, such as electrons or ions, moving through an electrical conductor.

Current = the rate of flow of electrons in a conductor, and it's measured in amperes (I).

Resistance

Resistance measures how well a material or object conducts electricity. Low resistance means the object conducts electricity well, high resistance means the object does not conduct electricity well. It counteracts the flow of current.

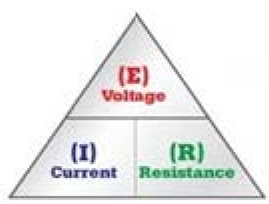
Resistance values are measured in Ohms. (Ω or R)

48.

Ohm's Law

Ohm's law states that the current through a conductor between two points is directly proportional to the voltage across the two points.

- I = Current in Amperes (A)
- V = Voltage in Volts (V)
- P = Power in Watts (W)
- R = Resistance in Ohm (Ω)
- Current equals Voltage divided by Resistance ($I = \frac{V}{R}$)
- Resistance equals Voltage divided by Current ($R = \frac{V}{I}$)
- Voltage equals Current times Resistance ($V = IR$)

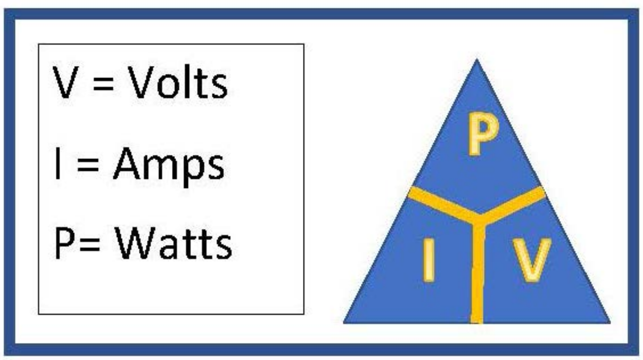


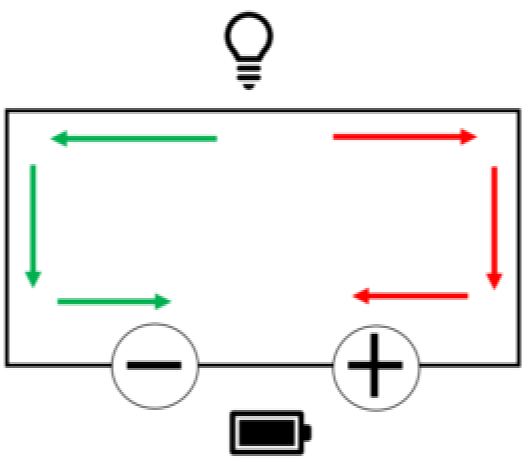
49.

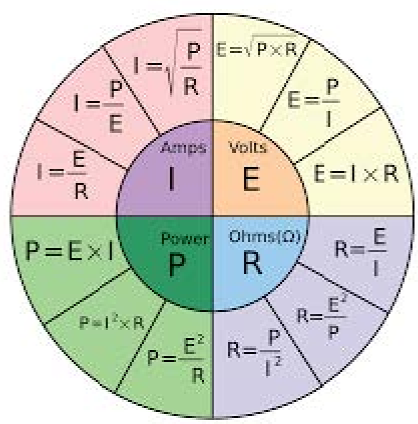
Watt's Law

Watt’s law defines the relationship between power, voltage and current and states that the power in a circuit is a product of the voltage and the current. There are many practical applications of Watt’s law, and the formula to calculate Watt’s Law is P = IV.

People often ask, what is the difference between Watt’s law and Ohm’s law? While Ohm’s law defines the relationship between resistance, voltage, and current in a circuit; Watt’s law defines the relationship between power, voltage, and current. These formulas can also be used to derive several other formulas.







In this DC circuit, the switch is closed (turned ON).

- Voltage is the power source—the “potential difference” between the battery’s two poles—is activated, creating pressure that forces electrons to flow, as current, out the battery’s negative terminal.

- Current reaches the light, causing it to glow.
- Current returns to the power source.

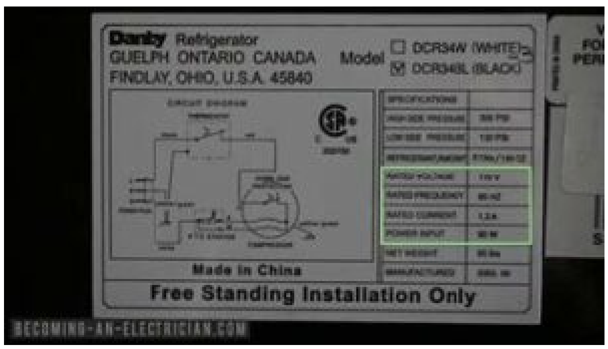
A household AA alkaline battery, offers 1.5 V. Typical household electrical outlets offer 120 V. The greater the voltage in a circuit, the greater its ability to “push” more electrons and do work.

50.

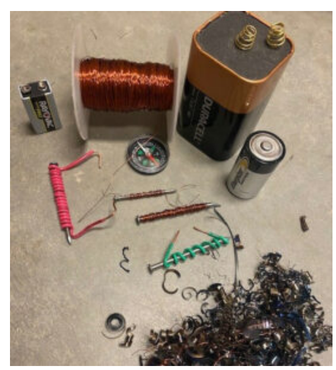
Circuits

Circuits are used to deliver energy to a load—from a small device to a household appliance to an industrial motor. Loads often carry a nameplate that identifies their standard electrical reference values, including voltage and current. In place of a nameplate, some manufacturers provide a detailed schematic (technical diagram) of a load's circuitry. Manuals may include standard values.

These numbers tell a technician what readings to expect when a load is operating normally. A reading on a digital multimeter can objectively identify deviations from the norm. Even so, the technician must use knowledge and experience to determine the factors causing such variances.



Create an Electro Magnet



Materials: 6V battery, copper wire, 2 alligator clips, and a large nail

Wrap the middle of the wire around the nail, then attach an end to each of the battery terminals with your alligator clips. The nail will attract paper clips and other small ferromagnetic objects. Experiment and see how the number of times you wrap the wire around the nail effects the strength of its magnetic qualities.

51.

Reading a Multimeter

A multimeter is an electrical tool used to measure electricity.

Functions of a Multimeter

- **On/Off Switch**: Some multimeters have an on/off button or switch. If yours does, turn it off when you're done testing. Other models have an auto-off feature to save battery life.
- **Display:** This can be digital or analog. A digital multimeter shows a number when you measure. An analog display has a meter and an indicator pointing to a number.
- **Meter Pointer (analog only)**: A straight line, often red, moves to show the electricity property you selected.
- **Selector Knob or Button**: Turn this knob or press the button to select your unit of measure. The choices on the display match the choices on the knob.
- **Resistance:** This is measured in ohms.
    - On analog multimeters, there's a scale on the display labeled as ohms, resistance or the ohm symbol (Ω).
    - On digital ones, look for similar tags next to a number.
- **Scales:** On an analog multimeter, you'll have different types of scales.
    - DC/AC Voltage Scale: These are labeled "AC" or "DC" and have a V for "voltage."
    - DC/AC Current Scale: These also say "AC" or "DC," but there isn't a V.
- **Selector knob labels**: On an analog multimeter, you choose the unit that you're testing. A wavy line indicates AC. A straight line or dash shows DC.
- **Jacks or Ports**: These holes look like headphone jacks or auxiliary jacks. Most have three ports, but some meters have four. Here are some types of ports you may see:
    - Common Port: This is the grounding or neutral port. The port is black. All multimeters have this.
    - V Omega m-A: This red port is used for testing most measurements. Use it to measure volts, resistance and small-amp currents. The tiny currents are measured in milliamps.
    - 10-A: This red port is used less frequently. It's for handling large currents up to 10

    - amps.
    - 300mA: This red port measures up to 300 milliamps.
- **Probes:** Also called leads, a multimeter has two probes that plug into the ports.
    - The black probe always plugs into the common port. It doesn't carry live electricity and is neutral.
    - The red probe plugs into the port for the unit or property you're measuring. It tests voltage, resistance or frequency. It's the positive or hot wire.

Your multimeter likely came with probes with pointy metal ends. You can get alligator clips that'll clamp onto your surface if you'd prefer. It looks like someone split the probe in half and gave it teeth. Alligator clips keep both hands free to adjust the multimeter.

Check the multimeter

Before you begin, make sure all parts of your multimeter look sound. This may seem unnecessary, but it's an important step when using an electrical tester. Checking your equipment helps protect you from mishaps that can result in electrical shock.

Assure that the area you're testing is dry. Check for cracks on the multimeter and for any fraying or nicks in the wires. Don't test if your equipment is damaged. If you'd like to feel even safer when testing, wear rubber gloves and shoes with rubber soles.

Now that you've ruled out obvious damage, it's important to check that your probes are working internally. Some people call this "ohming-out" the leads:

- Set your multimeter to the ohm meter on the selector knob.
- Plug the black probe into the common port.
- Insert the red probe into the jack marked for ohms.
- Gently tap the red and black tips together. Avoid touching the metal parts with your fingers while you do that.
- Your reading should be 0.5 ohms or less.
- If your reading is higher than that, replace the probes.

Alternating Current – AC

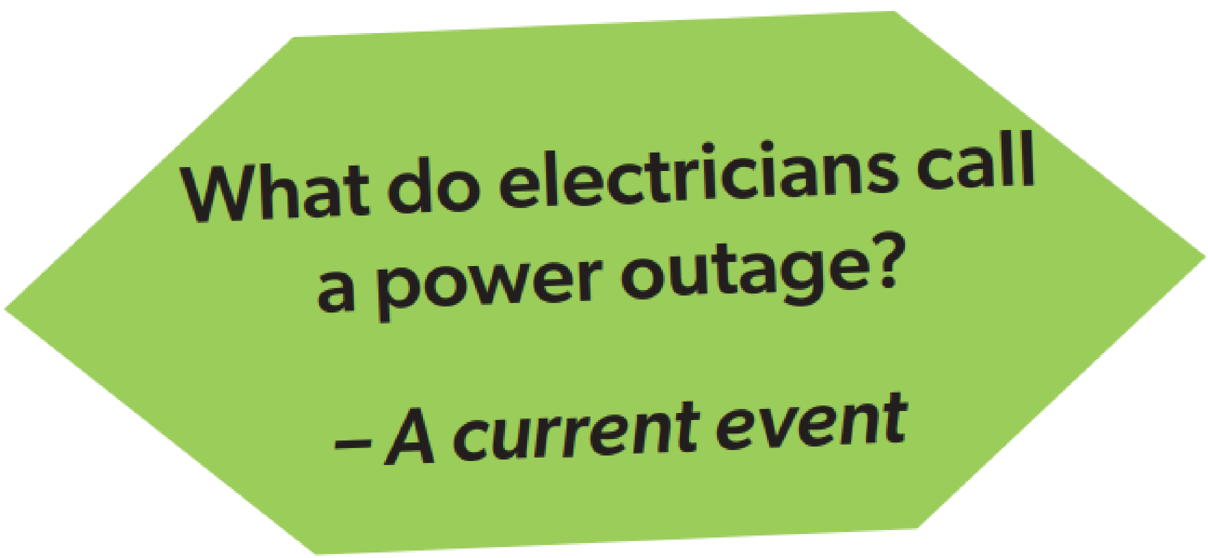
Measuring AC voltage is the most common usage of a multimeter. You can check the plug on an appliance or outlet to help isolate an electrical problem.

Tip: If your multimeter has an automatic function, change it manually to the correct AC mode. You'll get more accurate results on a digital multimeter.

Follow these steps to check an electrical plug. If you're testing another electric device, the concept is the same:

1. Turn off all power to the plug. This includes circuits and the plug itself, if applicable.
2. Set the mode on your multimeter to AC voltage. Start at the top of the range and adjust down.
3. Make sure your multimeter is set higher than the voltage number printed on the cord. For small two-prong appliances, that's usually 120 volts. Three-prong appliances will have a higher voltage.
4. Connect the black probe to the common jack on the multimeter.
5. Plug the red probe into the jack labeled as AC voltage or ohms/omega. It may also be labeled VΩmA, VΩ or V (for voltage).
6. Place the end of the black probe into the neutral slot. On a polarized plug, it's the wider prong.
7. Put the red probe into the hot slot on the plug.
8. Check your reading. A small hand mixer might be 120 volts, but a coffee grinder could be 300 volts.
9. When you're done, remove the red probe, then the black from the item you're testing. Unplug in that same order.

Safety Tip: If you must test an AC main, use a multimeter rated Category II or higher. However, it's recommended that you call a professional.



Direct Current – DC

Use a multimeter to check DC voltage. The concept is the same wherever you measure DC voltage. Check a power bank with a similar procedure as a battery.

Follow these steps to test the charge on a battery:

- Disconnect the battery from any power tools or chargers. Car batteries can be tested in place after the headlights have been on for two minutes, then turned off.
- Set your multimeter to measure DC voltage. Use the selector knob or button to choose the expected measurement. For example, if you're expecting 9 volts from your battery, set it to 9 or 10. In the U.S., it's usually 30 volts or less. You can also start at the top of the range and work your way down.
- Insert the black probe in the common jack.
- Plug the red plug into the jack labeled for DC voltage, VΩ or V–.
- Touch the black plug to the negative side of the battery.
- Touch the red probe to the positive terminal.
- Write down your reading.
- Disconnect the red probe, then the black one.

Tip: If your digital multimeter reading is negative, switch the black and red probes for a positive reading. It should be the same number, but without a minus symbol. Don't mix up the positive and negative sides with an analog multimeter. It may damage the tool.

Resistance

Measuring resistance is useful for DIYers who repair electrical components. Resistors need to carry the correct amount of power to function.

Here's how you can test resistors for a repair project:

- Completely disconnect the component that you're testing. Remove it from all live circuitry, including plugs and batteries. You want zero current flowing.
- Set your multimeter to the ohm meter function. If your resistor is labeled with a number, set it to that.
- Plug your multimeter probes into the jacks labeled common and VΩ (DC voltage). Use the black plug for common and the red plug for DC voltage.
- If you're not sure of your range, start measuring around 200-ohms or higher. Some models will show a "1" reading. This means the resistor has a higher capacity than your current setting.
- Touch the probes to either side of the item you're testing. Positive and negative doesn't matter here.
- Move down the ohm range on your multimeter gradually. When you're in range, the reading will make sense. The "1" or "OL" on a digital multimeter will change to a number.
- If you're not getting a proper reading, turn down the multimeter range. A high setting won't pick up low ohms.

If you’re testing multiple resistors, try using alligator clip probes. They clip on to make measuring easier.

52.

Understanding the Rule for Powers of Ten

Raising 10 to a power means multiplying 10 by itself a certain number of times. The number of times you multiply 10 is equal to the exponent. So, for example, 10 to the power of 3 means multiplying 10 by itself 3 times, resulting in the number 1000.

This looks like $10^3 = 10 \times 10 \times 10 = 1000$

Electrical Units

Electricians use quantities in very large numbers or very small numbers.

- Large Unit Example: Transmission lines transmit at voltages of 500,000 volts.
- Small Unit Example: Computers deal in currents of 0.000 000 001 amperes.

It is very easy to miss a zero when writing the numbers out!

The solution is to express all of the numbers in terms of POWER OF 10.

Engineering notation uses only those powers of 10 with an exponent that is a multiple of three.

Example: 10^{-9} , 10^{-6} , 10^{-3} , 10^{3} , 10^{6}

Each one of these engineering metric notational values is associated with a prefix. Instead of writing a number with a large power of 10, a metric prefix which represents the multiplier is placed ahead of the UNIT.

Example:

25 000 Volts = 25 × 103 Volts = 25 Kilovolts = **25 kV** (the kilo represents 103)

It is important to learn the prefixes in order to convert from one to another. The following can help!

Common Unit Prefixes

Prefix	**Name**	**Exponent**
P	pico	10^{-12}
N	nano	10^{-9}
µ	micro	10^{-6}
m	milli	10^{-3}
no prefix	no prefix	$10^{0} = 1$
k	kilo	10^{3}
M	mega	10^{6}
G	giga	10^{9}

Example

EXPRESS 2 500 Volts in Kilovolts:

2 500 V = ________ kV

Replace the Prefixes with the appropriate powers of 10.

2 500 X (100 V) = ________ X (103) V

The power of 10 on the right-hand side is bigger than the power of ten on the left.

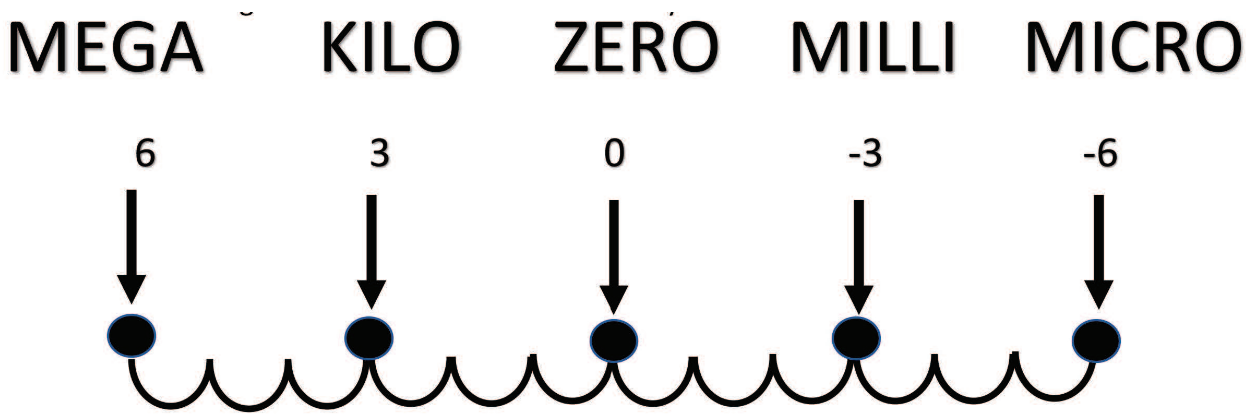
To keep the equation balanced the coefficient must be reduced by the same factor. That is, divided by 103.

To divide by 103 , move the decimal point of the coefficient three places to the left

2 500 X 100 V =2.5 X 103 V
2 500 = 2.5 kV

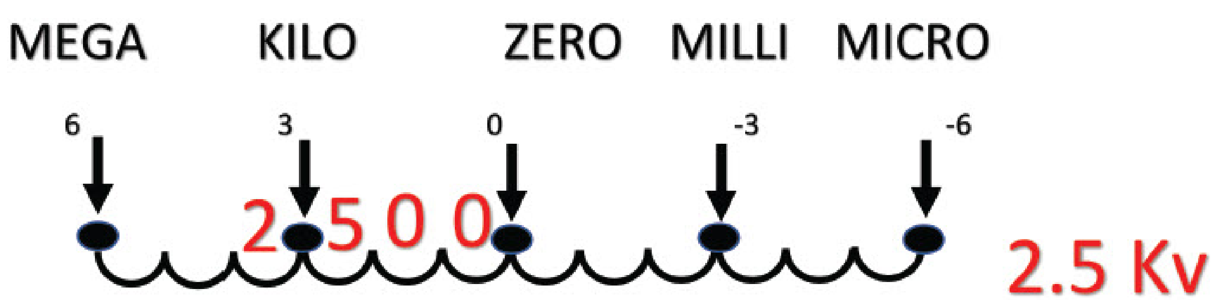
53.

Converting Between Metric Prefixes



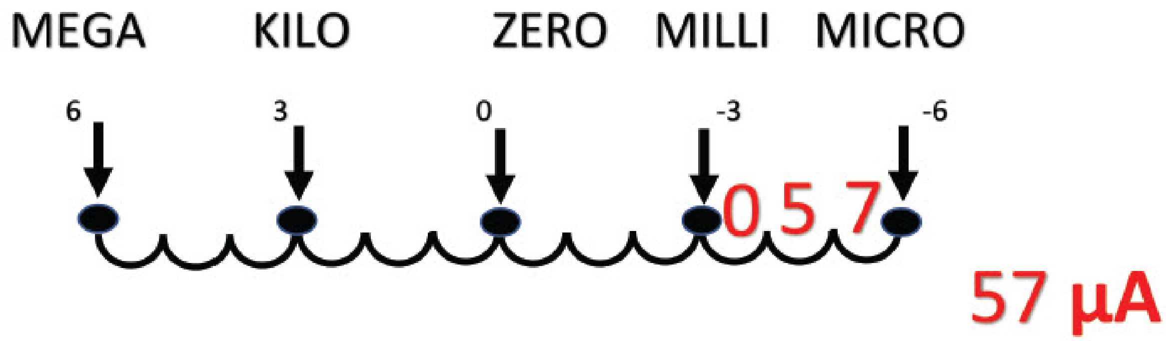
EXAMPLE 1

Express 2500 Volts in Kilovolts



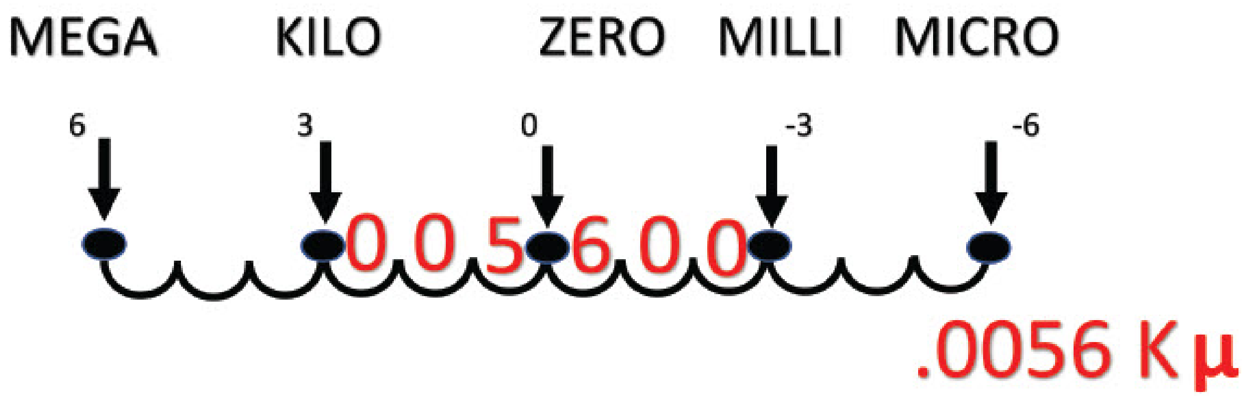
EXAMPLE 2

Express 0.057 Milliamps in Microamps



EXAMPLE 3

Express 5 600 Milliohms in Kiloohms



Conversions

An amp is the measure of the amount of current or electrical energy that is passing through an electric line, whereas a Watt is the unit for measuring electrical power. It is calculated by multiplying the voltage (V) and the current (amps) being used.

Here's the formula for calculating amps to watts:

Wattage = Amps × Voltage

For example, if you have a 120V device with a 20 Amp label, that's equivalent to a wattage of 2400. In equation form, that is: 20A × 120V = 2400W

Formula for Converting Watts Into Kilowatts:

P(kW) = P(W) / 1,000
(1 kilowatt = 1000 watts)

For example, if you wanted to convert your 1500W dishwasher to kilowatts, you would do the following calculation:

P(kW) = 1,500W / 1,000 = 1.5kW

Formula to Convert Kilowatts to Megawatts:

P(MW) = P(kW) / 1,000

The power in Megawatts is equal to the power in Kilowatts divided by 1000.

This formula also means that if you would like to convert watts to megawatts, you have to add three more zeros to your equation. The power in megawatts P(MW) can be found by dividing the power in watts P(W) by 1,000,000.

Here's the Formula to Convert Watts to Megawatts:

P(MW) = P(W) / 1,000,000

For example, if you convert a 100-watt light bulb to megawatts, you will do the following calculation:

P(MW) = 100W / 1,000,000 = 0.000100MW

Kilowatt = a measure of 1,000 Watts of electrical power

Kilowatt-Hour = electrical energy equivalent to a power consumption of 1,000 Watts for 1 hour

Formula for Calculating Watts Into Kilowatt-Hours:

kWh = (watts × hrs) ÷ 1,000

For example, to find the kWh of 1,200 watts for 3 hours:

kWh = (1,200 × 3) ÷ 1,000
kWh = 3,600 ÷ 1,000
kWh = 3.6

Here's the Formula for Calculating Kilowatt-Hours Into Watts:

watts = (kWh × 1000) ÷ hrs

For example: let's find the watts of power for 3.6 kWh of energy used in 3 hours.

watts = (3.6 kWh × 1,000) ÷ 3 hrs
watts = 3,600 ÷ 3 hrs
watts = 1200 W

54.

Activities

Calculating Electrical Terms

1. The statement which correctly represents Ohm's law:
   a. V = IR
   b. V = R/I
   c. R = VI
   d. I = R/V
2. A 10-ohms resistor is powered by a 5-V battery. The current flowing through the source is:
   a. 10 A
   b. 50 A
   c. 2 A
   d. 0.5 A
3. If V = 50 V and I = 5 A, then R = ?
   a. 50 Ω
   b. 5 Ω
   c. 10 Ω
   d. 2 Ω
4. If P = 50 watt and R = 2 ohms, then I = ?
   a. 50 A
   b. 5 A
   c. 10 A
   d. 2 A
5. Unit of voltage is:
   a. Volt
   b. Watt
   c. Coulomb
   d. Ampere
6. Unit of current is:
   a. Volt
   b. Watt
   c. Coulomb
   d. Ampere
7. Unit of power is:
   a. Volt
   b. Watt

c. Coulomb
d. Ampere

8. Unit of resistance is:
   a. Volt
   b. Watt
   c. Ohms
   d. Ampere
9. If I = 5 A and R = 10 Ω, then P = ?
   a. 50 watts
   b. 250 watts
   c. 350 watts
   d. 500 watts

Watt's Law (Power) problems:

10. P = 10 watts, I = 2 amperes, then E = ___________ V
11. E = 100 volts, I = 0.5 amps, then P = ___________ W
12. P = 500 watts, E = 250 V, then I = ___________ A

Answers

1. V = IR
2. 2 A
   Solution: From I = V/R = 5-V/10 ohm = 0.5 A
3. 10 Ω
   Solution: From R = V/I = 50 V/ 5A = 10 Ω
4. 5 A
   Solution: From I = √(P/R) = √(50 V/ 2A) = √25 A = 5 A
5. Volt
6. Ampere
7. Watt
8. Ohms
9. 250 watt
   Solution: Here P = I2R = (5 A)2 * 10 Ω = 250 watts
10. 5V
    Solution: Here 10W/2A = 5V
11. 50W
    Solution: Here 100V × .5A = 50W
12. 2A
    Solution: Here 500W/250V = 2A

Practical Competency "Use Multi Meters"

Never measure Resistance and use the Ohmeter function on a live circuit.

Objective

To complete this Practical Competency you will be expected to use a Various Analogue meters, a Digital Multimeter (DMM) and a Clamp-on Ammeter. Meters are used daily in the field for safety testing and troubleshooting purposes. Using them correctly and safely is vital. The purposes of this Practical Competency are:

- To safely use various meters to measure Voltage, Current and Resistance
- To correctly use different types of meters (Analog and Digital)
- To demonstrate the affect of increasing resistance in an electrical circuit

Safety

- Students must have steel toe boots, appropriate clothing, and safety glasses for use in the labs
- Students must perform a Hazard assessment of the work area.
- Never use the Ohmmeter function on a live circuit
- If you are unsure about using a Meter or piece of equipment, consult the user manual.

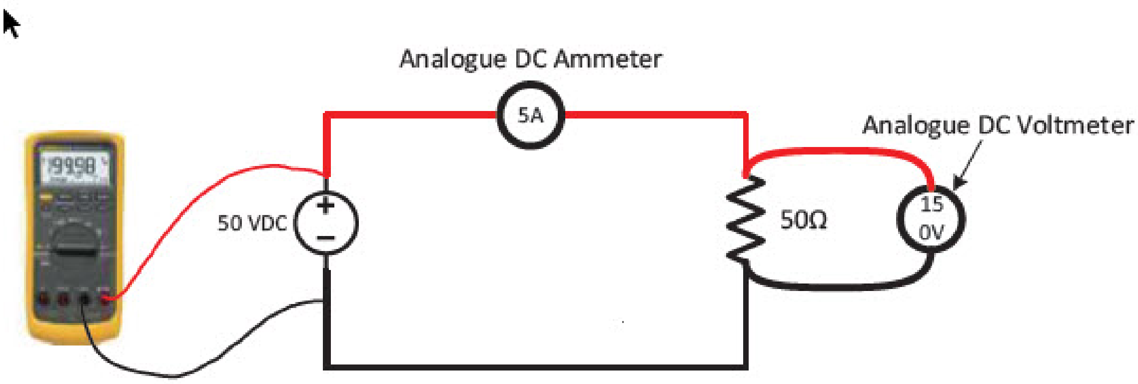
Equipment and materials

- Elworthy Bench (Electrical Bay #1)
- Digital Multimeter and Clamp-on Ammeter (Tool Crib)
- Assortment of Test Leads (Tool Crib)

Using Ohm's and Watt's Law, calculate the expected circuit values and record in Table 1

*Only measure resistance when circuit is de-energized!

1. Calculate values first.
2. Obtain the material listed above, from the Tool crib and choose an Elworthy bench that is not in use.
3. Measure the 50, 100 and 150 Ω Resistors to confirm their values and ensure that they are functioning and record your measurements in Table 2 before connecting in the circuit below.
4. Connect the Circuit shown below, using the variable DC power supply and starting with the 50 Ω Resistor. Connect the analogue meters supplied on the Elworthy bench, in to the circuit.



5. Have your instructor check your circuit before energizing
6. Energize the circuit and adjust the voltage to 50 Volts on the dial. Measure and record the current and voltage values of the meters in Table 2. Turn on digital meter and set to DC Volts. Using the digital meter across the source.
7. De-energize the circuit and replace the 50 Ω resistor with the 100 Ω resistor. Measure and record your current and voltage readings in Table 1.
8. De-energize the circuit and replace the 100 Ω resistor with the 150 Ω resistor. Measure and record your current and voltage readings in Table 2.

Observations

Table 1: Calculated Values

	Voltage	**Current**	**Measured Wattage**
Resistor #1 = 50 Ω		I=E/R	P=EXI
Resistor #2 = 100 Ω	50V		

Table 2: Analogue Meters

	Voltage	**Current**	**Measured Resistance***
Resistor #1 = 50 Ω			
Resistor #2 = 100 Ω			
Resistor #3 = 150 Ω			

*Only measure resistance when circuit is de-energized

Questions

1. Why is it important to measure the resistors before connecting them to the circuit?
2. What happened to the current in the circuit when the resistance value doubled from 50 Ohms to 150 Ohms? Why?
3. What happens to the current value as the resistance is decreased? Why?
4. What happens to the Wattage as the Current decreases? Why?

Answers to Questions under Practical Competencies: "Use Multi Meters"

1. Resistance value is different then measured. Measure Resistance on unenergized

2. I = 50 Ω / 50 Ω   I= 1 AMP   R DOUBLED

I = 50 Ω / 100 Ω   I = 0.5 AMP I HALVED

3. I = E (Same) / R (went down)

For example: I = 50 V / 25 Ω   I = 2A

R= Halved

I= Doubled

4. P = E X I à Go to Calculation Table

At Home Practical Competencies

How Much Does It Cost to Charge a Tesla?

Tesla has been around since 2003, but now that electric cars are becoming more common, they're also becoming more affordable. As gas prices are going up, the cost to charge electric vehicles is going down. Take a look at this example which explains how much it costs to charge a Tesla Model 3 at a home charging station:

- The battery capacity is 75kW, and our current average electricity rate that we're going to use is 13 cents per kWh
- This means that your charging cost is equal to 75 × $0.13 = $9.75 for a complete "fill up" that will get you around for approximately 240 miles.
- Compare charging the Teslato filling up a smaller car that has a 12-gallon gas tank. When we use a gasoline cost of $3.85 per gallon, it's pretty clear that the $46.20 you spend on filling up your car with gas (12 × $3.85 = $46.20) is way more expensive than using the Tesla charging station. It may get you 300-400 miles of drive time, but even charging the Tesla twice is less than half the cost of one tank of gas.

How Do I Calculate the Consumption of an Electrical Appliance?

How Do I Estimate What My Electricity Bill Will Be?

Let's use the national average rate of around 13 cents per kWh to calculate how much it costs to power a 100-watt light bulb every hour. Since it takes 100 watts of power to work — to convert the power in watts to kilowatt-hours — you will multiply 100 watts by one hour. Then, you'll divide by 1,000 to find the energy usage in kWh.

- Energy = (100 × 1) ÷ 1,000 Energy = 100 ÷ 1,000
- Energy = 0.1 kWh Hourly cost = electricity cost per kWh ÷ energy use in kWh
- Hourly cost = $0.13 ÷ 0.1 kWh Hourly cost = 1.3 cents
- If electricity costs 13 cents per kWh, then a 100-watt light bulb will cost 1.3 cents for every hour that it's on. Most electric bills are calculated monthly.

To estimate your monthly costs, you can follow these steps:

Estimate how many hours per day you use that light bulb on average. (Let's say it's 5 hours). Multiply the light bulb's watts by the average number of hours you use it daily instead of the one hour used in the formula above. (Let's say your light bulb is 60 watts, so that you would calculate 60 watts × 5 hours).

Solve the equation above using your light bulb's actual wattage and the actual average number of hours you use that light bulb per day.

(60 × 5 = 300 ÷ 1,000 = 0.3 kWh)

Divide your area's average electricity cost by your light bulb's average daily kWh. ($0.13 ÷ 0.3 kWh =43 cents per day.

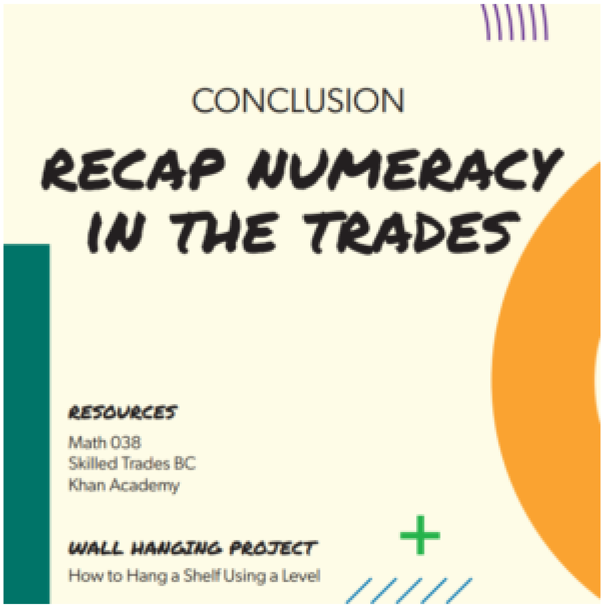
Multiply your answer by 30 to get the monthly average kWh for that light bulb. In this case, $0.43 × 30 days = $3.90. It would cost you $3.90 per month to leave a 60-watt light bulb on for an average of 5 hours per day, every day.

Repeat this equation for all light bulbs, appliances, and other electrical devices in your home.

Add up the total to find your estimated monthly electricity costs in kilowatt-hours. You may be surprised to see how fast it all adds up.

VIII

Conclusion - Recap on Numeracy in the Trades



55.

Math 038

The math you need to know and practice in order to pass the MATH 038 assessment at Camosun College.

Intended Learning Outcomes

At the end of the course, students will be able to:

1. Demonstrate knowledge and skills in using the principles and operations of various math topics such as arithmetic, measurement, graphs, formulas, and geometry
2. Apply a variety of strategies in solving math-related problems
3. Apply knowledge and skills in various math topics to solve problems related to particular Trades Foundation Programs (except Professional Cook and Electrical programs)
4. Use knowledge of various math topics as a basis for further study in Trades Foundation Programs
5. Convert between fractions, decimals, and percent
6. Add, subtract, multiply and divide rational numbers
7. Solve application problems involving arithmetic, metric and imperial measurement, graphs, formulas, and geometry
8. Use order of operations
9. Use the common metric and imperial units for temperature, length, volume and mass
10. Convert between and within metric and imperial units using tables and/or calculators
11. Use formulas to solve related application problems
12. Read, write, and use ratios and proportions to solve percent and other application problems
13. Distinguish between significant digits, accuracy, and precision
14. Use a calculator to find squares, cubes, square roots, and cubic roots of whole numbers, fractions, and decimals
15. Extract and interpret information from line, bar and circle graphs
16. Draw line and bar graphs
17. Solve equations, formulas, and related application problems
18. Use a protractor, compass and straightedge to measure angles, bisect lines,

angles and arcs, find the centre of a circle and construct a perpendicular to a line

19. Use the Pythagorean theorem and properties of triangles to find missing sides and angles

56.

Math Help at Camosun

Camosun College Math Help Centres

Website: Camosun College Math Help Centres

Refresh your math skills, work on math assignments or find learning support for specific math topics. From math basics to advanced calculus or trades-specific skills, find learning support at the Math Help Centers.

Hours and locations

Camosun has four math help centres to support your Math and Stats courses, as well as Math for trades and nursing programs. Hours vary between semesters and around exam time. Check the webpage and the doors of each help centre for updates.

Trades and Apprenticeship Math

- Tuesday 3-5pm Interurban, John Drysdale Building (JD) Room 142
- Wednesday 3-5pm Interurban, Jack White Building (JW) Room123
- Thursday 3-5pm Interurban, Huber Hall (HH), Room 128: Foundations Math, Tutoring for Math 02, 03, or 05 courses
- Monday – Thursday 9am-4pm, Friday 9am-12:30pm Interurban, Academic Upgrading Help Centre, CBA Building, Room 109
- Monday – Thursday 4:30-8pm Lansdowne, Math Help Centre, Ewing Building, Room 342 166

College Prep Math courses

Support for Math 072-097, 107, 115, 139 courses

- Monday – Thursday 4:30-8pm Lansdowne, Math Help Centre, Ewing Building, Room 342
- Monday – Friday 9am-4:30pm Lansdowne, Math Lab, Ewing Building, Room 224
- Monday – Thursday 10am-3pm Interurban, Math Lab, Technologies Building, Room 142: University Transfer Math or Stats courses, Includes math for elementary education, computing, and engineering
- Monday – Friday 9am-4:30pm Lansdowne, Math Lab, Ewing Building, Room 224

- Monday – Thursday 10am-3pm Interurban, Math Lab, Technologies Building, Room 142
- Monday – Thursday 4:30-8pm Lansdowne, Math Help Centre, Ewing Building, Room 342

Three ways to get help

1. Drop into one of the Help Centres for face-to-face support
2. Book a session in Microsoft Teams for Live Chat support
3. For quick questions email mathlab@camosun.ca. Please include your name and course number (e.g. Math 053). Feel free to add photos of your work and/or textbook. We'll do our best to respond within 24 hours (excluding weekends).

Camosun Math Help Centre FAQs

Can I make an appointment with a Math tutor?

Yes, the math labs and help centres offer online appointments through TEAMS as well as a drop-in service on a first-come, first-served basis.

Can I get help with other subjects other than Math and Stats?

Math help centres and labs are for students currently in Math or Stats courses or completing the math components of trades or nursing programs. We can sometimes help with math questions related to other Camosun courses. We also have help centres specific to English, writing, and science.

Can I use a computer?

The Math Lab (Ewing 224), Math Help Centre (Ewing 342) and Academic Upgrading Help Centre (CBA 109) have some computers available for the students. Maple software is available on computers in Ewing 224, as well as in the general purpose computer labs.

MATH 038 – Math for General Trades

Credits: 0 Total Hours: 150

Students in this course will complete a brief trades-oriented review of the basic computational and problem-solving skills required for further study in various Trades Foundation programs. Topics include: whole numbers, fractions, decimals, proportion, percent, powers, roots, graphs, formulas, measurement, and geometry.

MATH 037 – Math for Professional Cook

Credits: 0 Total Hours: 150

Students in this course will complete a brief trades-oriented review of the basic computational and problem-solving skills required for further study in the Professional Cook Foundation Program. Topics: whole numbers, fractions, decimals, proportion, percentage.

Camosun – Math Requirements for Trades

Not sure which to take? Contact an admissions advisor.

High school course Camosun alternative courses

High school course	Camosun alternative courses
Math 10	MATH 052 Intermediate Math 1 and MATH 053 Intermediate Math 2
Math 11	MATH 072 Advanced Math 1 and MATH 073 Advanced Math 2
Math 11	MATH 075 College Preparatory – Applications of Mathematics
Math 11	MATH 077 College Preparatory – Mathematics 1
Math 12	MATH 097 College Preparatory – Mathematics 2
Math 12	MATH 107 Applied Precalculus
Math 12	MATH 115 Precalculus

Notes:

- Math prerequisites assume the academic version of the courses (unless otherwise noted).
- Math 10 refers to either Principles of Math 10 or Foundations of Mathematics and Pre-calculus 10.
- Math 11 refers to either Principles of Math 11 or Pre-calculus 11.
- Math 12 refers to either Principles of Math 12 or Pre-calculus 12.
- The Math 11 prerequisite for Business courses (e.g. BUS, ECON, FIN, etc.) may be satisfied with one of:
    - C grade in Principles of Math 11 or Applications of Math 12
    - C+ grade in MATH 072, MATH 075, or MATH 135 (cancelled Sept 2019)

- You will need a minimum of an A grade in MATH 107 in order to use it as a prerequisite for MATH 100.

57.

Resources

Khan Academy

Khan Academy is an American non-profit educational organization created in 2008 by Salman Khan. Its goal is creating a set of online tools that help educate students. The organization produces short lessons in the form of videos. Its website also includes supplementary practice exercises and materials for educators.

Khan Academy offers practice exercises, instructional videos, and a personalized learning dashboard that empower learners to study at their own pace in and outside of the classroom. We tackle math, science, computing, history, art history, economics, and more, including K-14 and test preparation (SAT, Praxis, LSAT) content. They focus on skill mastery to help learners establish strong foundations, so there's no limit to what they can learn next!

Why Khan Academy works

Personalized learning: Students practice at their own pace, first filling in gaps in their understanding and then accelerating their learning.

Trusted content: Created by experts, Khan Academy's library of trusted practice and lessons covers math, science, and more. Always free for learners and teachers.

Tools to empower teachers: With Khan Academy, teachers can identify gaps in their students' understanding, tailor instruction, and meet the needs of every student.

Assessment

Math or Trades Math Assessment

Admission Requirements

Camosun Programs and Courses

Choose your desired trade admissions math requirements will be listed

Skilled Trades BC – Essential Skills

ITA Essential Skills was created to help people prepare for success in the first two levels of technical training during their apprenticeship.

Skilled Trades BC

Exam and Study Supports

Math Help at Camosun College: Duncan McDougal

A big Thanks to Duncan for his help editing the Math in this text. Duncan McDougal is a math teacher by trade. He has been teaching for over 45 years and was kind enough to edit the mathematics in this book. His teaching certificate comes from McGill University in Quebec, Canada. Duncan has published “fast fractions” which is part of the D2L curriculum at Camosun. He has also published over ten articles for Vector Magazine between 2004- 2010.

Check out Duncan’s Tutoring help at tutorfind.ca

Tutorfind Learning Centre — TutorFind is a group of educators dedicated to inspiring, challenging, nurturing and empowering learners to reach their educational goals.

58.

Trades at Camosun College

Automotive trades

Automotive Service Technician Foundation

Certificate – 30 weeks
Provides entry into the automotive mechanical repair trade, and provides possible accreditation toward Year 1 Apprenticeship training.

Heavy Mechanical Trades

Certificate – 10 months
These tradespeople are in constant demand to keep essential heavy-duty vehicles in top running order for the booming construction, transportation, mining and forestry industries.

Automotive Service Technician

Red Seal – 7 weeks

Diesel Engine Mechanic

Red Seal – 8 to 10 weeks

Heavy Duty Equipment Technician

Red Seal

Transport Trailer Technician

Red Seal

Truck and Transport

Red Seal

Wood Trades

Carpentry Foundation

Certificate – 25 weeks
We'll teach you the skills and knowledge necessary to get started as a carpenter and build a solid future for yourself and your community.

Fine Furniture/Joinery Foundation

Certificate – 10 months
Looking for a program that combines traditional woodworking and joinery skills with creativity and design? The Fine Furniture program will provide the foundation you need to start a career as a cabinetmaker, or design and build your own custom pieces.

Carpenter

Red Seal – 7 weeks

Construction Craft Worker

Red Seal – 4 weeks

Culinary & Horticulture

Professional Cook (Level 1 & 2)

Certificate – 28/14 weeks
Learn the fundamentals of food preparation in all aspects of a modern industrial kitchen.

Professional Cook (Level 1 & 2)

Certificate – 28/14 weeks
Learn the fundamentals of food preparation in all aspects of a modern industrial kitchen.

Professional Cook 1

BC Certificate of Qualification – 6 weeks

Professional Cook 2

BC Certificate of Qualification – 6 weeks

Professional Cook 3

Red Seal – 6 weeks

Horticulture Technician

Certificate – 10 months
Prepares you for employment in the horticulture industry in areas such as landscaping, landscape maintenance, parks, golf courses, retail garden outlets, greenhouses, silviculture, wholesale nurseries and plant propagation.

Electrical

Electrical Foundation

Certificate – 25 weeks
You'll learn to install, maintain, design and upgrade a wide variety of electrical systems including commercial and residential wiring systems, heating, lighting and power distribution systems, electrical equipment and alternate energy generating equipment, alarm and data systems, and industrial systems.

Construction Electrician

Red Seal – 10 weeks

Pipe Trades

Plumbing & Pipe Trades Foundation

Certificate – 30 weeks
The training programs prepare you for entry level employment and apprenticeships within a diverse field of trades including plumbing, gasfitting, sprinklerfitting and steam/pipefitting.

Refrigeration & Air Conditioning Mechanic Foundation

Certificate – 30 weeks
Focuses on the first-year competencies that are common to all of the piping trades. You'll work through common core, occupational core and refrigeration & air conditioning specialty modules.

Domestic/Commercial Gasfitter

BC Certificate of Qualification – 10 weeks

Plumber

Red Seal – 6 to 8 weeks

Refrigeration & Air Conditioning Mechanic

Red Seal – 6 to 10 weeks

Sprinkler Fitter

Red Seal – 8 weeks

Steam/Pipefitter

Red Seal – 6 to 8 weeks

Metal Trades

Sheet Metal & Metal Fabrication Foundation

Certificate – 30 weeks
Opens doors to apprenticeships and careers in construction, shipbuilding and manufacturing.

Welder Foundation

Certificate – 28 weeks
Conforming to industrial standards, practices and procedures, this competency-based program provides you with the skills you'll need to prosper in today's job market.

Metal Fabricator

Red Seal – 6 or 7 weeks

Sheet Metal Worker

Red Seal – 6 or 8 weeks

Welder

Red Seal – 8 or 10 weeks

59.

Activity - Hanging Your Shelf

[How to hang shelves (Home Depot)](#)

Gather Your Tools and Materials

Before you begin, gather the necessary tools and materials:

- Wall-mounted shelves
- Shelf brackets
- Pencil
- Tape measure
- Standard level
- Stud finder
- Screws
- Drywall anchors
- Screwdriver
- Drill
- Hammer

Determine the Placement

- Before you start hanging a shelf, decide where it should be placed. Weight plays a big role in finding a suitable installation spot. Consider the weight of the shelf and the weight of each item you intend to place on top.
- For denser shelving or heavier display or storage items, you can use a stud finder to see if there's stud in the area you want to hang the shelf. Wall studs offer additional support, but if there are none available, you can also use drywall anchors.

Mark the Position

- Have someone help you hold the shelf against the wall. Use a standard level to make sure it's placed in a straight line, then lightly mark the wall with a pencil on both ends.
- Position the shelf brackets against the wall along the bottom of the shelf. Mark inside the holes so you know exactly where to insert the screws.
- Remove the shelf and the brackets from the wall. Review your markings to make sure everything is properly labeled.

Drill Starter Holes

- Use a screwdriver or a power drill on the lowest speed to drill starter holes with the screws into the bracket markings.
- Do not twist the screws all the way into the wall.

Install the Anchors and Brackets

- Remove the screws and put the first bracket into place. If the shelf is on the heavier side and you weren't able to find a stud, install a wall anchor.
- Re-insert screws into the brackets and tighten until each bracket is secure.
- When screwing the brackets into place, make sure not to over-tighten them.
- Take a moment to tidy the pencil markings and drywall dust.

Tip: Review our complete guide on how to install stationary brackets for detailed information.

60.

Goals

In this course I learned:

I still need to improve on:

My next steps are:

61.

Recognition & Thanks

Graphics

Jennifer Playford

Mathematics Editing

Duncan McDougal

Wall Hanging Project Blueprint Drawing

Elizabeth Grayer

Carpentry Information

Al Van Akker, RSE

Pipe Trades Information

Andrea Durdle, RSE

Automotive Information

Patrick Jones, RSE

Andrew Bullen, RSE

Electrical Information

Carmen DeGoey, RSE

Culinary Information

Wendy Okopski, RSE

Kathleen Robertson, RSE

Editing

Richard Williams

Ulrich Hansen

Sue Aitchison, RSE

Photographs , Charts/Diagrams/Illustrations, Writing & Research

Karynn Scott, RSE

62.

About the Author

Karynn attended Camosun College for the Women in Trades Training program. She also completed her welding Foundations, Levels B and A, her Class A pipe tickets and her Red Seal at Camosun. Now an employee of Camosun, as well as a Welding Red Seal Exam Prep Tutor, Karynn loves working with minority groups as well as helping those with learning disabilities or challenges. She understands the frustration of boring Mathematics explained in a dull way, and hopes this book helps you find the fun in math, and using what you learn to build, create and grow. Her main belief for overcoming the challenges of Numeracy: practice makes progress.

This is where you can add appendices or other back matter.