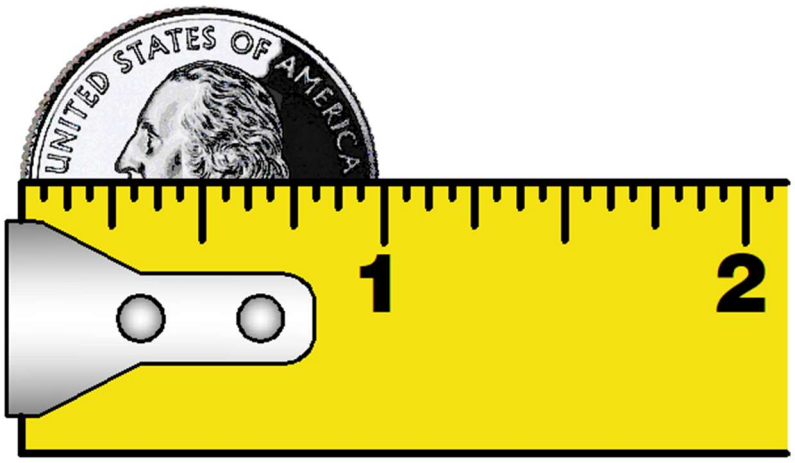
DELTA MADE
—WORKFORCE—
FUTURES

PRACTICAL MATH

A Workbook for Manufacturing and the Skilled Trades

MEASUREMENT • FRACTIONS • PRACTICAL ARITHMETIC



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Their involvement in workforce development and commitment to the region have helped guide our efforts to provide practical, accessible educational resources for individuals preparing for careers in manufacturing and the skilled trades.

We especially appreciate the collaboration of Coahoma Community College in connecting educational resources with the needs of local learners and employers.

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Contents

Acknowledgments 2

Introduction 4

Unit 1: Understanding Units of Measure 5

Unit 1 - Review Questions 12

Unit 1 - Instructor Answer Key 15

Unit 2: Doing Math with Units 16

Unit 2 - Review Questions 22

Unit 2 - Instructor Answer Key 25

Unit 3 - Introduction to Fractions 26

Unit 3 - Review Questions 34

Unit 3 - Instructor Answer Key 38

Unit 4: Introduction to Percentages 39

Unit 4 – Review Questions 46

Unit 4 – Instructor Answer Key 50

Unit 5: Ruler Fractions 51

Unit 5 – Review Questions 60

Unit 5 – Instructor Answer Key 64

Math with Ruler Fractions 65

Unit 6 – Review Questions 72

Unit 6 – Instructor Answer Key 76

Introduction

Math is an important part of everyday work in manufacturing and the skilled trades. Whether measuring materials, calculating dimensions, reading instruments, or estimating quantities, workers regularly use basic mathematical skills to solve practical problems.

This workbook is intended for individuals preparing to enter the manufacturing workforce, including those pursuing their first job, learning a new trade, or developing skills for a different career. It is also useful for current workers who want to strengthen or refresh their basic math skills.

The lessons introduce fundamental mathematical concepts through practical examples drawn from manufacturing and related trades. The emphasis is on understanding and applying mathematics to real workplace situations rather than memorizing formulas or procedures.

Each lesson includes explanations, examples, and practice exercises. QR codes provide access to accompanying instructional videos that demonstrate the concepts and offer additional guidance.

No advanced mathematical background is required. Learners are encouraged to work through the material at their own pace, either independently or as part of a training program.

Unit 1: Understanding Units of Measure

Practical mathematics is math applied to real-world problems that people in manufacturing and the skilled trades need to solve every day. The numbers we use in these applications have meaning. They represent real things, such as quantities of materials, dimensions, temperatures, or periods of time.



One of the most important numbers in practical math is the number one. The number one represents a single, complete unit of something. Knowing exactly what that unit represents is an important first step toward using numbers correctly.

What Is a Unit?

A unit tells us what we are counting or measuring. A unit might represent a person, a length, a period of time, a temperature, or a particular workpiece. It can also represent a group of things taken as a whole, such as a class, a truckload, or a production batch.

For example, we call a group of 60 minutes one hour, and a group of 24 hours one day. In each case, we have defined a unit that represents a particular amount of something.

Whenever we perform calculations in real-world applications, we need to be certain that we are using the correct units.

Consider a purchasing agent who needs to order 1,000 bolts. If the bolts are packaged in boxes containing 50 bolts each, the correct order would be 20 boxes. Accidentally ordering 1,000 boxes instead of 1,000 bolts would result in receiving 50,000 bolts—a costly mistake caused by confusing the units.

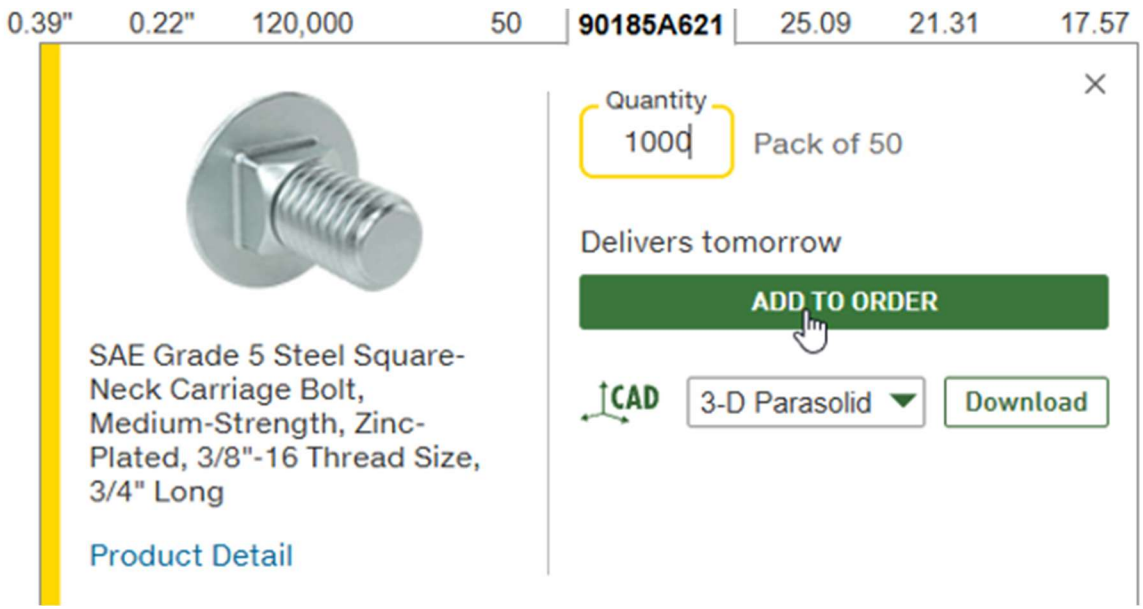


Figure 1. Counting bolts and counting boxes are not the same thing. (Image: McMaster.com)

Units of Length

In the United States, two measurement systems are commonly used: the U.S. Customary System and the Metric System.

The U.S. Customary System uses length units such as miles, feet, and inches. The Metric System, more precisely represented by the International System of Units (SI), uses meters and related units such as centimeters and millimeters.

One inch is defined as exactly 25.4 millimeters.

Manufacturing equipment and measuring instruments may use inches, millimeters, or both. For example, many digital calipers can display measurements in either inches or millimeters. The same dimension will have different numerical values depending on which unit is selected.



Figure 2. A digital caliper can display the same dimension in different units.

When using instruments or equipment, always identify the units before interpreting a measurement. Look for labels, symbols, or notes that indicate which units are being used. If the units are unclear, ask someone familiar with the equipment before proceeding.

Throughout this workbook, we will emphasize the importance of units. Whenever you encounter a number, ask yourself: What are the units? What does one of those units represent? Once we know that, the number begins to tell us something useful about the real world.

Units in Everyday Applications

Units appear in many familiar products, instruments, and machines.

Pressure — Pounds per Square Inch (PSI)

A pressure gauge on an air tank may display pressure in PSI. This abbreviation stands for pounds-force per square inch. A pressure of one PSI means that a force of one pound acts on each square inch of surface area.



Figure 3. Pressure gauges often display pressure in PSI.

Speed — Miles per Hour (MPH)

A car's speedometer commonly displays speed in miles per hour, abbreviated MPH. One mile per hour means traveling a distance of one mile in one hour. We can write miles per hour as a fraction: miles divided by hours.

Units also help us understand calculations. For example, a vehicle traveling at a constant speed of 50 miles per hour for three hours would cover a distance of:

$$50 \frac{\text{miles}}{\cancel{\text{hours}}} * 3 \cancel{\text{hours}}$$

$$= 150 \text{ miles}$$

50 miles/hour × 3 hours = 150 miles

Notice that the hours cancel, leaving miles as the unit of the answer.



Figure 4. Speed is a distance traveled per unit of time.

Area — Square Feet

A package of aluminum foil might contain 75 square feet of material. Square feet measure area, which is calculated by multiplying one length by another.

One square foot is the area of a square measuring 12 inches wide and 12 inches long. Because 12 × 12 = 144, one square foot is equal to 144 square inches.

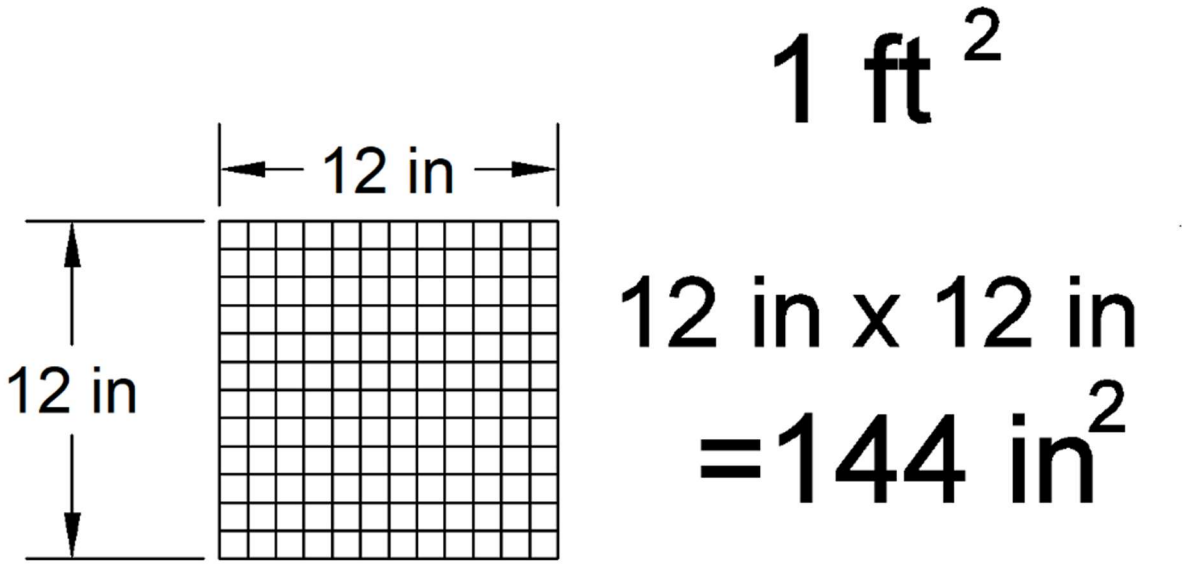


Figure 5. Square feet describe area rather than length.

Counting — Individual Items and Packages

A box labeled as containing 54 seal-top bags represents a quantity of 54 individual bags. The box itself can also be considered one unit, but that unit contains 54 smaller units. This is another example of why it is important to know exactly what is being counted.



Figure 6. One package can contain many individual items.

Machine Speed — Feet per Minute (FPM)

A metal-cutting bandsaw may have a speed chart showing recommended blade speeds for different materials. These speeds are often expressed in feet per minute, abbreviated FPM.

One foot per minute means that the blade travels a distance of one foot in one minute. Like miles per hour, feet per minute is a unit of speed: feet divided by minutes.

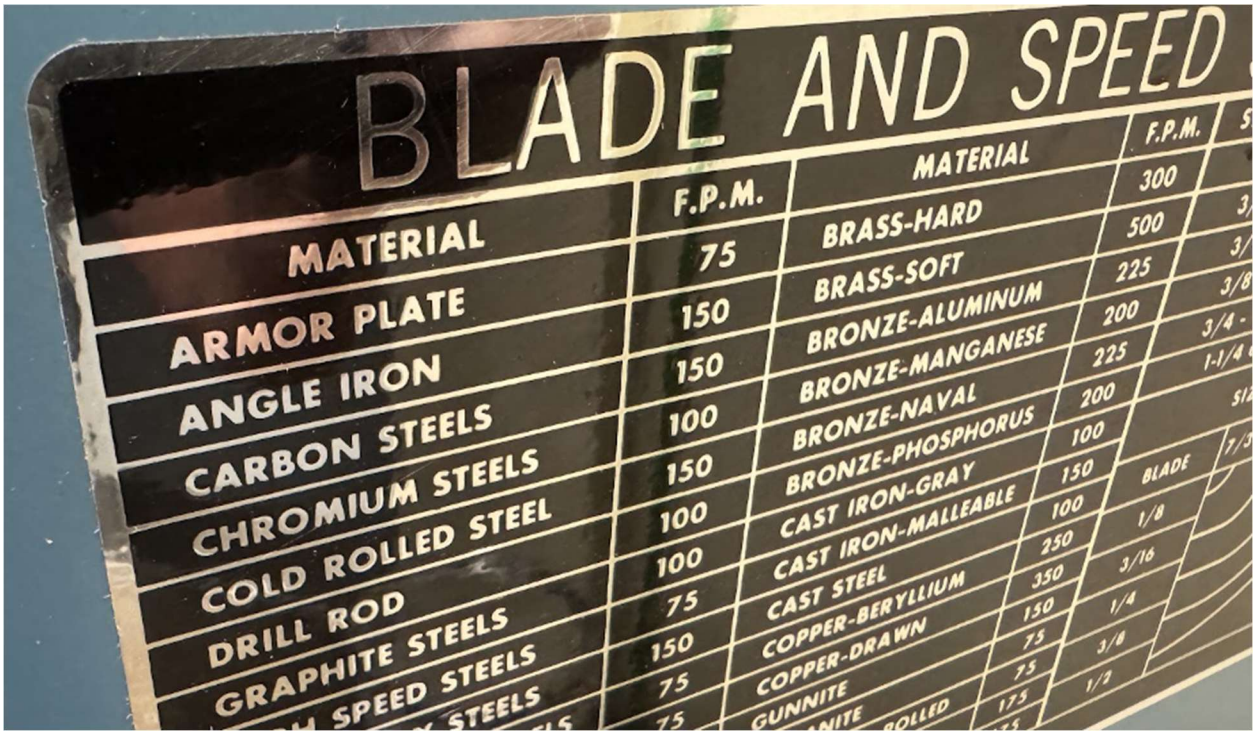


Figure 7. Bandsaw blade speed may be expressed in feet per minute.

Understanding Measuring Tapes

One of the most common measuring tools in manufacturing and the skilled trades is the measuring tape.

Many measuring tapes used in the United States are graduated in feet and inches. One foot is equal to 12 inches. Some tapes also include metric graduations, typically in centimeters and millimeters.

A meter is slightly longer than a yard. One meter contains 100 centimeters or 1,000 millimeters.

Unlike digital instruments, measuring tapes may not clearly label every unit. It is important to recognize the graduation markings and understand which measurement system is being used.

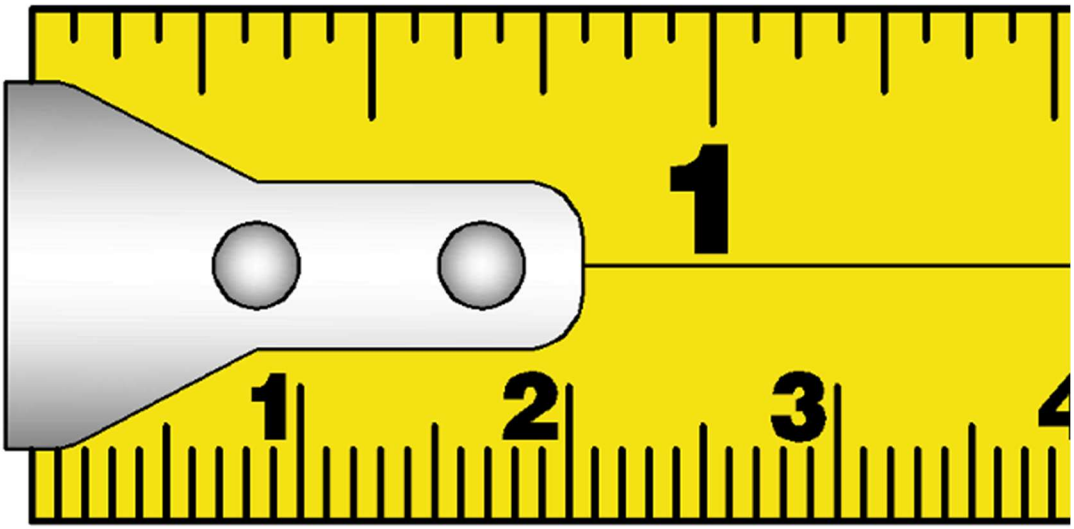


Figure 8. Inch and metric measuring tapes use different graduation systems.

Dividing Units into Smaller Parts

Measurements do not always involve whole units. We often need to divide a unit into smaller parts to describe a dimension more precisely.

For example, an inch can be divided into halves, quarters, eighths, or sixteenths. A meter can be divided into 100 centimeters or 1,000 millimeters.

Understanding how units are divided into smaller parts will become especially important when we begin working with fractions, measuring instruments, and precise dimensions.

Lesson Summary

Numbers used in practical mathematics often have units that tell us what those numbers represent. Units can describe things we count, such as parts or boxes, or things we measure, such as length, area, time, speed, and pressure.

We have also introduced some common units from the U.S. Customary and Metric Systems and seen how they appear in everyday products and equipment.

Whenever you work with numbers in a real-world application, make it a habit to ask: What are the units, and what do those units represent? Understanding units is an important first step toward interpreting measurements and using numerical information correctly in manufacturing and the skilled trades.

Unit 1 - Review Questions

Understanding Units of Measure

Name: _____ Date: _____

Choose the best answer, calculate where requested, or write a brief response. Include units when requested.

1. A purchase order calls for 1,000 bolts. Each box contains 50 bolts. How many boxes are needed?

A. 10 boxes
B. 20 boxes
C. 50 boxes
D. 1,000 boxes

2. A caliper displays 25.4 mm. Which measurement describes the same length in inches?

A. 0.1 in
B. 0.5 in
C. 1 in
D. 2 in

3. A bandsaw chart lists a blade speed of 180 FPM. What does FPM describe?

A. Feet of blade travel per minute
B. Feet of stock cut per hour
C. Force applied per minute
D. Feed pressure measured in pounds

4. A tank pressure gauge reads 90 PSI. Which quantity does the reading describe?

A. Length
B. Area
C. Pressure
D. Speed

5. A roll of sheet material is labeled 75 square feet. What is being described?

A. The length of the roll
B. The area of the material
C. The thickness of the material
D. The weight of the roll

6. A work order specifies 12 parts, but the shipping carton holds 12 parts. Which order is equivalent to 12 parts?

A. 12 cartons
B. 2 cartons
C. 1 carton
D. 24 cartons

7. Which unit is most appropriate for the length of a small, machined part?

A. Millimeters
B. PSI
C. Square feet
D. Miles per hour

8. A tape measure shows both inch and metric scales. What should you do before recording a dimension?

A. Use whichever number is larger
B. Identify the scale and unit used
C. Round to the nearest whole number
D. Record both numbers as inches

9. A shop needs 360 washers. Each bag contains 30 washers. How many bags are needed?

Answer: _____

10. A delivery contains 8 boxes, each holding 25 fittings. How many fittings were delivered?

Answer: _____

11. How many inches are in 5 feet?

Answer: _____

12. How many millimeters are in 3 meters?

Answer: _____

13. A vehicle travels at a constant 40 miles per hour for 3 hours. How many miles does it travel?

Answer: _____

14. A rectangular sheet is 4 feet long and 3 feet wide. What is its area in square feet?

Answer: _____

15. Match each abbreviation to its meaning. Write the matching letter beside each item.
1. PSI 2. MPH 3. FPM
A. Feet per minute B. Pounds per square inch C. Miles per hour

Answers: 1_____2 _____3 _____

16. Match the quantity to the appropriate unit.
1. Air pressure 2. Sheet-metal area 3. Shaft length
A. Inches B. Square feet C. PSI

Answers: 1_____2 _____3 _____

17. Match each group to its equivalent number of smaller units.
1. One foot 2. One meter 3. One hour
A. 60 minutes B. 12 inches C. 1,000 millimeters

Answers: 1_____2 _____3 _____

Unit 1 - Instructor Answer Key

Understanding Units of Measure

Remove this section before distributing the student worksheet, if desired.

1. B — 1,000 ÷ 50 = 20 boxes.
2. C — 1 inch = exactly 25.4 mm.
3. A — FPM means feet per minute.
4. C — PSI is a unit of pressure.
5. B — Square feet measure area.
6. C — One carton contains 12 parts.
7. A — Millimeters measure length.
8. B — Identify the measurement system and unit first.
9. 360 ÷ 30 = 12 bags.
10. 8 × 25 = 200 fittings.
11. 5 × 12 = 60 inches.
12. 3 × 1,000 = 3,000 millimeters.
13. 40 × 3 = 120 miles.
14. 4 × 3 = 12 square feet.
15. PSI is pressure; MPH and FPM are speed units.
16. Pressure, area, and length use different units.

Unit 2: Doing Math with Units

When doing math for Real world applications, the units will always be important to consider. Let's take a look at some of the basic math operations and see how being careful with the units can keep us from making costly or embarrassing mistakes.

VIDEO

Doing Math with Units

Let's look at addition first of all. Most people learn early on that 2 plus 2 equals four, but what happens when we try to add two bolts to two feet of pipe? You can see that the answer is still two bolts and two feet of pipe. For values to combine together with addition, their units need to be compatible with each other. Even if the units represent the same idea, such as length, they still have to be the same before we can add their values together.

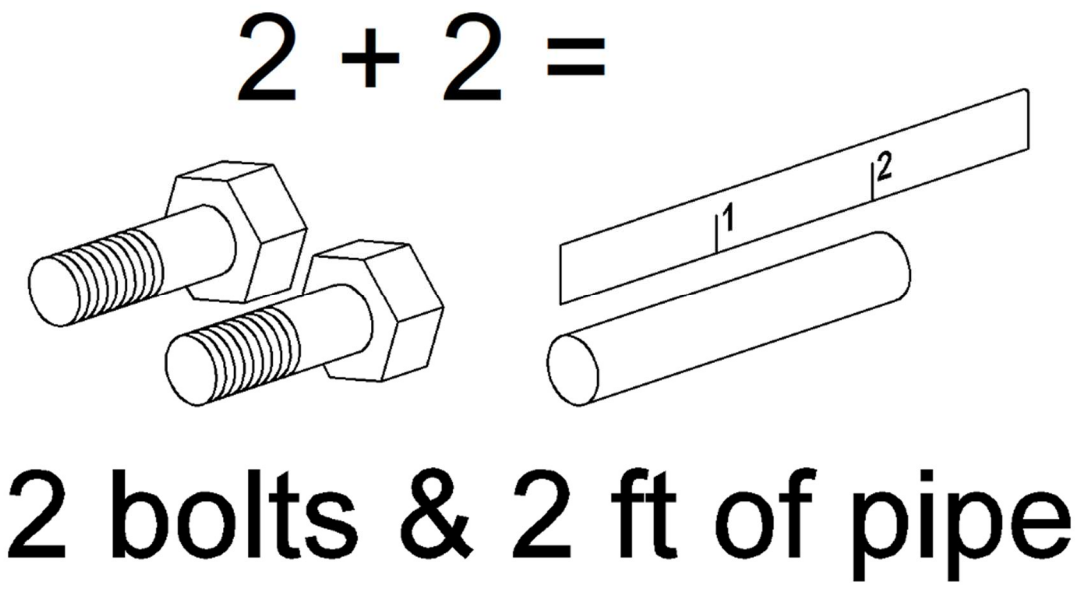


Figure 1 These quantities have different units

Let's look at another example. What happens if we add six inches to one foot. We can keep the feet and inches separate, and simply have one foot and 6 inches. It's common to use feet and inches this way, but if we want the values to actually combine together, we will need to do a conversion. It is much easier to do calculations with measurements if the units are all the same.

For example, we can convert 6 inches to .5 feet and add that half foot to our one foot to get 1.5 feet, or we could convert the one foot to 12 inches and add 6 more inches to get 18

inches total. 18 inches is the same length as 1.5 feet, but the values are different because the units are different. Once the units are the same, the math becomes a lot simpler.

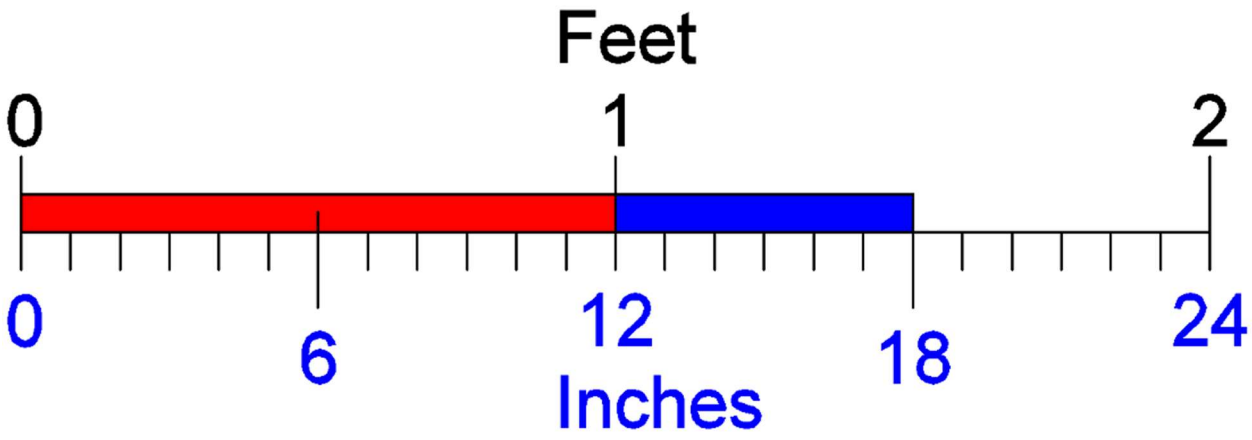


Figure 2 One and a half feet or 18 inches

Subtraction works the same way. If we subtract 10 inches from 30 inches, the units remain inches. There are even some cases, where we can have measurements that are less than zero. For example, a freezer can reduce a temperature to a negative value. A machine tool could indicate its position in one direction or another as a positive or negative value. It is important to ask yourself if a value makes sense when doing any kind of real world math. You can't have negative three bolts, or a length of steel that is less than zero.

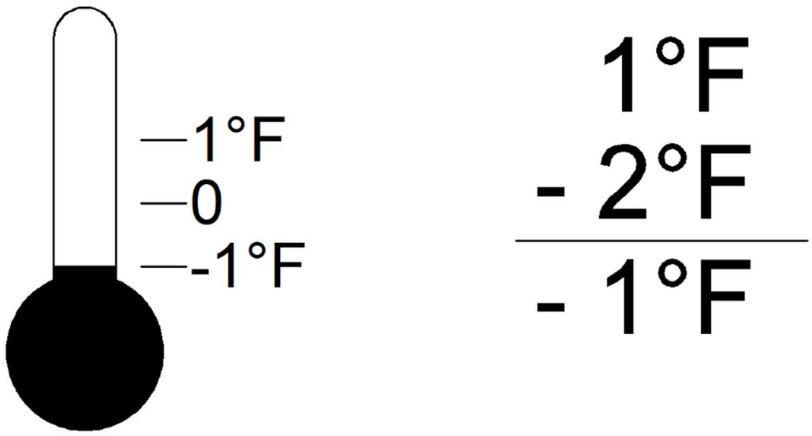


Figure 3 Some unitscan be negative

When we start multiplying with units, things get interesting, and we need to be even more careful. Let's start with a simple case: if we double a length, we get a length. For example, 30 inches times 2 = sixty inches. Notice that we did not multiply inches by inches, but inches by simply the number two. It's possible to use numbers that have no units in this

way. The two is multiplied by the 30 and makes it twice as big without affecting the length units.

Something completely different happens when we multiply inches by inches. Let's look at that a little more closely. Let's take this piece of steel and mark off 4 inches along the width. Now, let's multiply those four inches by 10 inches of length. The value becomes 40, and the units become inches times inches or inches squared. 40 square inches is now a measure of area, and not length.

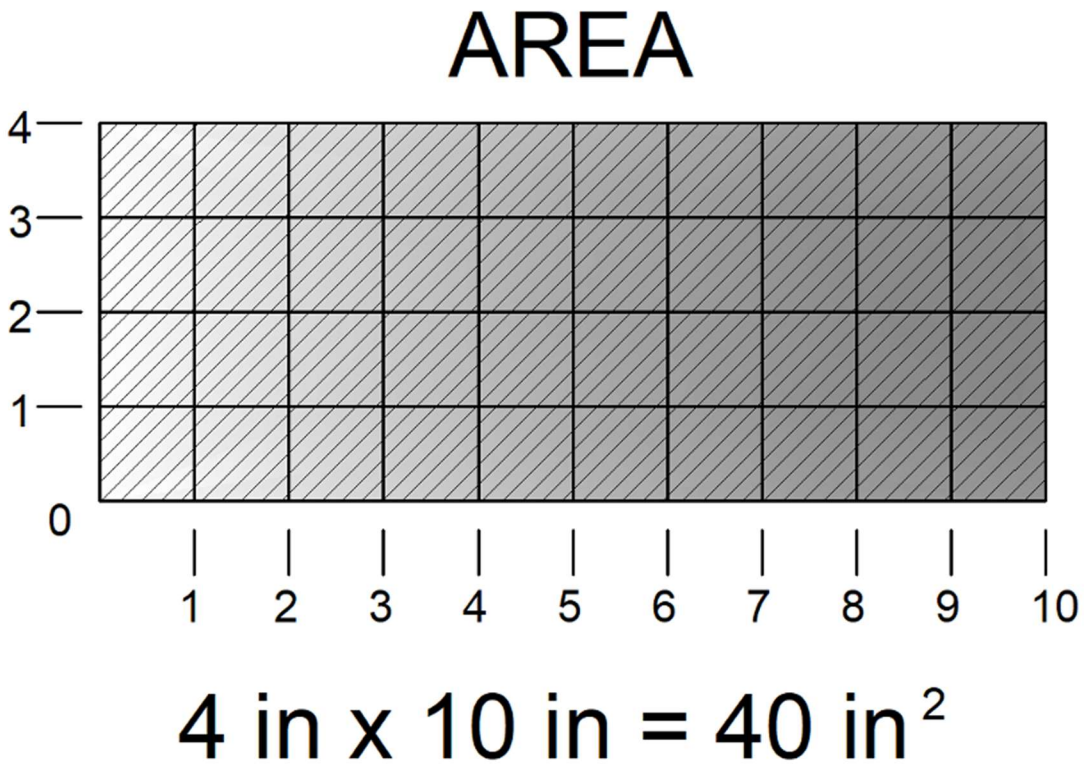


Figure 4 Length and area are different units

While we're talking about area, it might be helpful to keep in mind that while there are 12 inches in one foot there are 144 square inches in one square foot.

Here is another example of units changing when we do multiplication. It is common for structural steel to be designated by an overall size and its weight in pounds per foot. This is a length of C4x5.4. That is the depth is a nominal 4 inches, and the channel weight is 5.4 pounds per foot. It is helpful to notice that the word "per" means divided by. We can write pounds per foot as pounds divided by feet. Look closely what happens when we use multiplication to figure out how much a 10 foot length of this channel would weigh.



Figure 5 Feet times pounds per feet gives pounds

10 feet times 5.4 pounds per foot = 54 "pounds." What happened to the feet? When we did the multiplication, we wound up with feet divided by feet. This means the feet "canceled" out and became simply the number one. This means they no longer affect the value or the units. We were left simply with pounds. Let's look at division and maybe it will be a little more clear what happened.

But before we look at division, let's take a step back and remind ourselves what we are actually doing when we multiply. Let's say that these pins are put in groups of three. That means there will be 3 pins per group. We can multiply this number by the number of groups we have to find the total number of pins. If we have 4 groups of pins, then 3 pins per group times 4 groups equals 12 pins. Notice that the groups are now gone from our units.

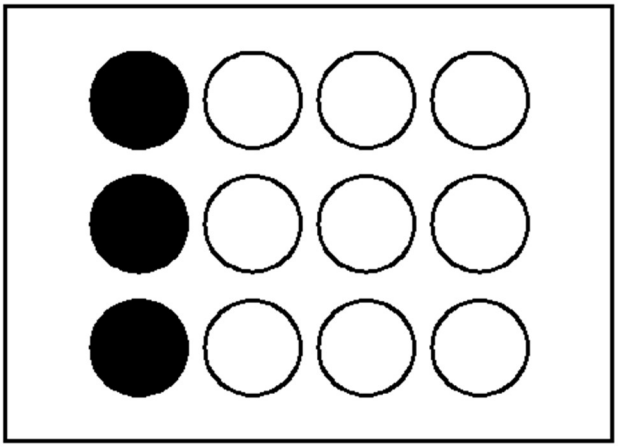


Figure 6 Four groups of three pins

Division works in the opposite direction. If we have 12 pins, and we divide them into 3 groups (12 divided by three), we will have 3 groups of 4 pins each. 12 pins divided by 3 groups equals 4 pins per group. We can talk about the number of pins, the number of

groups, or the number of pins per group, each will have a different value. 12 pins, 3 groups, and 4 pins per group.

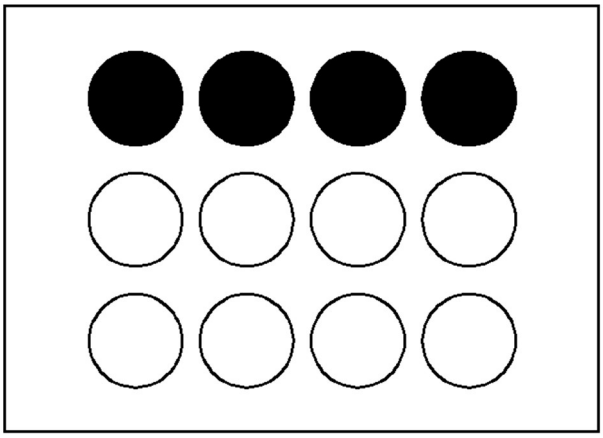


Figure 7 Three groups of four

Now, there are different ways we can write a division problem. We could use this "division" symbol and write 12 divided by 3. But let's look a little more closely at that division symbol. Notice that the division symbol looks like a fraction, with one dot above the line and another below it. One number over another number. We can write a division problem as a fraction -- one number over another number, and we would read it top to bottom. So 12 over three is the same thing as 12 divided by three.

$$12 \div 3 =$$

Figure 8 Twelve divided by three

If we review some of the basic fraction rules, it will help us to understand what happens when we combine units that are expressed as fractions, like miles per hour, pounds per square inch and pins per box.

First of all, remember that any number over one is just equal to that number. 12 divided by one is the same thing as 12. 12 pins divided into a single group is just a group of 12 pins.

Also remember that any number (except the number zero) over itself is equal to "one." Saying we have two halves or four quarters is the same as saying we have one of a thing.

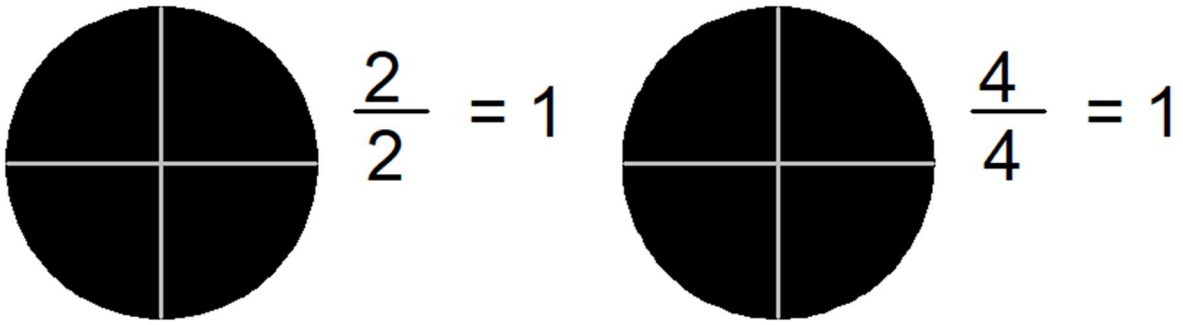


Figure 9 A number (except zero) divided by itself equals one

When you multiply fractions, all you do is multiply the top numbers (the numerators) and the bottom numbers (the denominators).

When we multiply miles over hours by some number of hours, the answer is miles times hours over hours. Using the same rules we just saw, we can rewrite this as miles over one times hours over hours. Miles over one is just miles, and hours over hours is just the number one. One times anything is just that thing, so miles times one is just miles. What we say is that the hours cancel out, and we usually do the canceling in a single step when we see that we can do it.

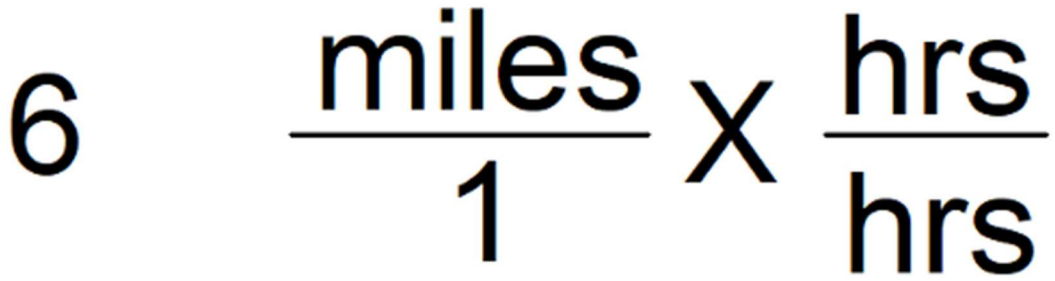


Figure 10 Miles per hours times hours gives miles

So in review: when we multiply or divide, the units are part of the calculation. Sometimes the units stay the same, sometimes they change, and sometimes a unit will cancel out completely.

We also learned that the word “per” means divided by, and that a fraction is another way of writing division. When the same unit appears on the top and bottom of a fraction, that unit divided by itself equals one, so we can cancel it out.

The important thing to remember is that units are not something we simply add to an answer when we are finished. Keep track of them as you work through the problem. They can help you understand what the numbers mean, help you work toward the correct answer, and help you recognize when an answer doesn’t make sense.

Unit 2 - Review Questions

Doing Math with Units

Name: _____ Date: _____

Directions: Select one answer for each multiple-choice question. For numerical questions, write only the requested number; the unit is given in the question. Complete each matching set by writing the letter of the correct response.

Part A | Multiple Choice

1. A worker has 2 bolts and 2 feet of pipe. Which statement correctly describes the total?

A. 4 feet of material
B. 4 bolts
C. 2 bolts and 2 feet of pipe
D. 2 feet of bolts

2. Which expression correctly adds 1 foot and 6 inches using one unit?

A. 1 + 6 = 7 feet
B. 12 + 6 = 18 inches
C. 1 + 6 = 7 inches
D. 12 + 6 = 18 feet

3. A machine axis reads −3 inches relative to its zero position. What does the negative sign indicate?

A. The machine has a negative physical length
B. The position is 3 inches in the negative direction
C. Three inches of stock disappeared
D. The measurement is invalid

4. A steel plate is 4 inches wide and 10 inches long. Which unit describes its area?

A. inches
B. inches per foot
C. square inches
D. cubic inches

5. The label 5.4 lb/ft on a structural channel describes its:

A. total weight
B. weight per unit length

C. width in feet
D. area in square feet

6. When a length in feet is multiplied by a weight per foot (lb/ft), what unit remains?

A. feet
B. feet squared
C. pounds
D. pounds per foot

7. What does 4 pins per group mean?

A. 4 groups of pins
B. 4 pins in each group
C. 4 pins total
D. 4 groups per pin

8. Which expression is equivalent to 12 divided by 3?

A. 3/12
B. 12/3
C. 12 × 3
D. 12 + 3

9. What is the value of 7/7?

A. 0
B. 1
C. 7
D. 14

10. Which unit results from multiplying 50 miles/hour by 3 hours?

A. miles
B. hours
C. miles/hour
D. hours/mile

Part B | Numerical Answer

11. Convert 2 feet to inches. Enter the number of inches only.

Answer: _____

12. Add 1 foot and 9 inches. Enter the total in inches.

Answer: _____

13. Subtract 7 inches from 30 inches. Enter the remaining inches.

Answer: _____

14. A rectangular plate measures 5 inches by 8 inches. Enter its area in square inches.

Answer: _____

15. A C4×5.4 channel weighs 5.4 pounds per foot. Enter the weight in pounds of a 12-foot piece.

Answer: _____

16. There are 5 groups of 3 pins each. Enter the total number of pins.

Answer: _____

17. Divide 24 pins equally among 6 groups. Enter the number of pins per group.

Answer: _____

18. A machine moves at 50 miles per hour for 3 hours. Enter the distance traveled in miles.

Answer: _____

Part C | Matching

19. Match each expression with the unit of its result.

1. _____ 6 inches + 3 inches
2. _____ 4 inches × 2 inches
3. _____ 8 feet × 2 lb/ft

Choices: A. square inches B. pounds C. inches

20. Match each quantity to what it describes.

1. _____ 12 pins
2. _____ 3 groups
3. _____ 4 pins/group

Choices: A. pins in each group B. total count of pins C. number of groups

Unit 2 - Instructor Answer Key

Unit 2 | Doing Math with Units

Remove this page when distributing the student worksheet.

Part A | Multiple Choice

1. C — 2 bolts and 2 feet of pipe. Different kinds of units cannot be combined by addition.
2. B — 12 + 6 = 18 inches. Convert the foot to 12 inches before adding.
3. B — The position is 3 inches in the negative direction. A signed coordinate indicates direction relative to a reference.
4. C — square inches. Multiplying length by length produces area.
5. B — weight per unit length. The word per means divided by.
6. C — pounds. Feet in numerator and denominator cancel.
7. B — 4 pins in each group. Per group specifies a rate for each group.
8. B — 12/3. A fraction bar represents division.
9. B — 1. Any nonzero number divided by itself equals one.
10. A — miles. Hours cancel, leaving distance.

Part B | Numerical Answer

11. 24. 2 × 12 = 24 inches.
12. 21. 12 + 9 = 21 inches.
13. 23. 30 − 7 = 23 inches.
14. 40. 5 × 8 = 40 square inches.
15. 54. 10 ft × 5.4 lb/ft = 54 lb.
16. 15. 5 groups × 3 pins/group = 15 pins.
17. 4. 24 ÷ 6 = 4 pins/group.
18. 150. 50 miles/hour × 3 hours = 150 miles.

Part C | Matching

19. 1–C; 2–A; 3–B.

20. 1–B; 2–C; 3–A.

Unit 3 - Introduction to Fractions

A lot of people don't like fractions. Maybe you remember working with them in school and finding them confusing. That's okay. We are going to keep this as straightforward as possible and concentrate on what fractions mean and how we can use them to solve real world problems.



VIDEO

Introduction to Fractions

Let's start with the basic idea. A fraction is really just a way of writing a division problem. You may have noticed that the "divide" symbol is one dot over another, like a tiny fraction. The fraction three-fourths, for example, means exactly the same thing as three divided by four. The number on top is called the numerator, the number on the bottom is called the denominator, and the line between them is a fraction bar. That fraction bar means divided by.

$$\frac{\text{numerator}}{\text{denominator}} = \frac{1}{2} = 1 \div 2 = 0.5$$

Figure 11 Fractions are division

Sometimes we actually perform the division. Three divided by four gives us 0.75. We could also describe the same amount as 75 percent. Other times, though, it is more useful to leave the answer as a fraction and simply write three-fourths. These are different ways of describing the same value.

Fractions describe some number of parts of a whole. If we divide a circle into four equal pieces, each piece is one-fourth of the whole. If we have three of those pieces, we have

three-fourths of the circle. Notice that the pieces have to be equal. Simply cutting something into four pieces doesn't necessarily give us fourths. We get fourths when the whole is divided into four equal parts.

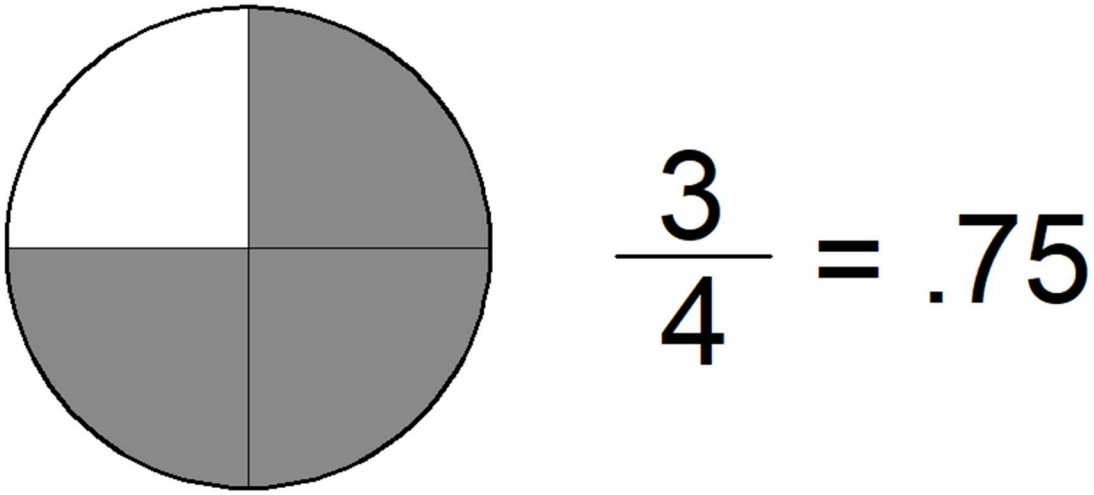


Figure 12 Three "Quarters " (fourths)

Here are 12 pins. Suppose three of them have been identified as non-conforming parts. Three out of our 12 pins are non-conforming. We can write that as three-twelfths. Once again, we have division: three divided by twelve. The fraction tells us what part of the entire group has been identified as non-conforming.

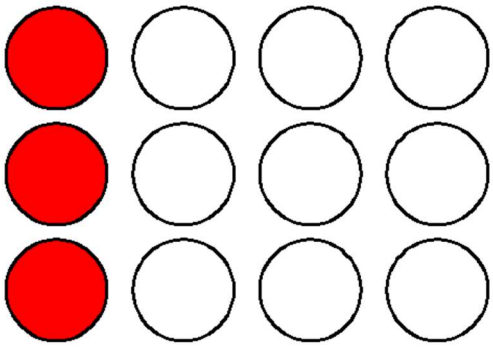


Figure 13 Three of the 12 are nonconforming

The denominator (on the bottom) has an important effect on the size of a fraction. If the numerator (on the top) stays the same and the denominator gets larger, the value of the fraction gets smaller. One-half is larger than one-fourth, and one-fourth is larger than one-eighth. That makes sense if we think about dividing something into pieces. The more equal pieces we divide it into, the smaller each piece becomes.

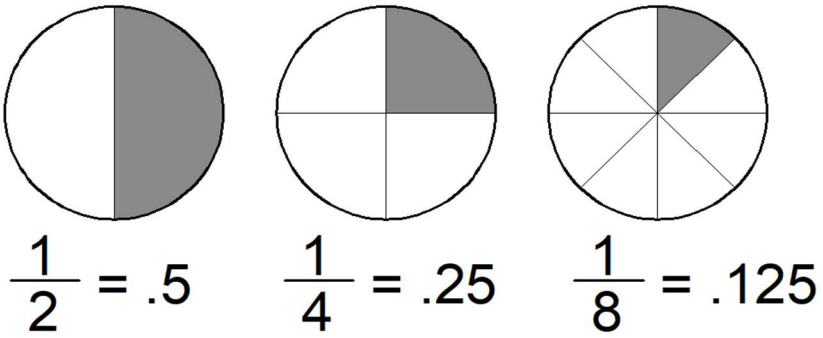


Figure 14 As the denominator gets larger, the value gets smaller

The numerator works in the other direction. If the denominator stays the same and the numerator gets larger, the fraction gets larger. Three-fourths is larger than two-fourths, and two-fourths is larger than one-fourth. The pieces are still the same size; we simply have more of them.

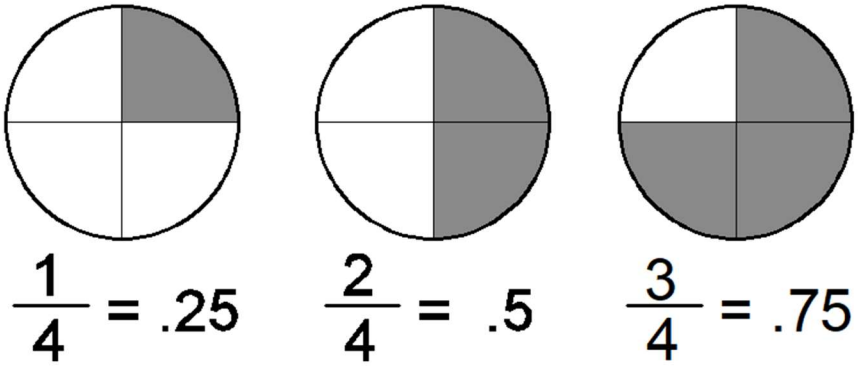


Figure 15 As the numerator gets larger, the value gets larger

There is one special idea that will be very useful when we start working with fractions. Any nonzero number divided by itself equals one. Two over two equals one. Four over four equals one. Twelve over twelve equals one. If we have all 12 pins out of a group of 12 pins, we have one complete group.

Suppose six of our 12 pins are selected. We could say that we have six-twelfths of the pins. We could also arrange the same pins into smaller groups and see that six out of twelve is one-half. We haven't changed the number of selected pins. Six-twelfths and one-half are simply two different ways of writing the same value.



Figure 16 Six twelfths is one half

In general, we want to write our fractions in what is called “simplest form.” If we see that we have a “*factor*” that is the same in the numerator as well as the denominator we can divide it out. For instance, 6/12 could be written 2*3/2*2*3. Notice that if we expand the numbers in this way, we can separate them into individual fractions. The ones that equal one (like this 2/2 and this 3/3) can be removed because anything times one is just that thing. It’s always a good idea to check to see if a fraction can be reduced to it’s simplest form.

$$\frac{6}{12} = \frac{2}{2} \times \frac{1}{2} \times \frac{3}{3}$$

Figure 17 Remember, any number (except zero) over itself is equal to one.

Sometimes we also need to clean up a fraction because the numerator is larger than the denominator. For example, five-fourths means five divided by four. There is nothing mathematically wrong with five-fourths. It simply has a value greater than one. When a fraction has a numerator that is larger than the denominator, We call it an improper

fraction, and we usually convert it to a mixed number, that is, a whole number and a fraction.

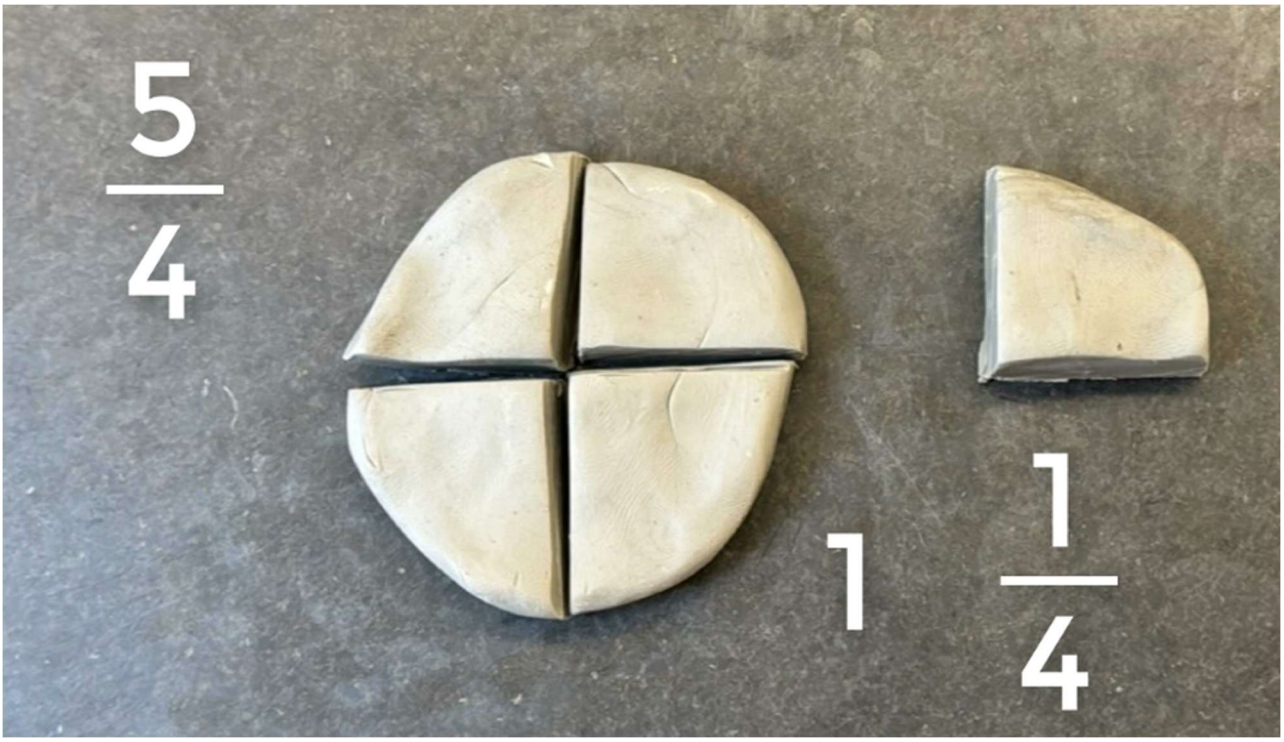


Figure 18 Five fourths is 4/4 + 1/4

Now let's look at doing math with fractions. Multiplication is actually one of the easier operations. To multiply two fractions, multiply the numerators together and multiply the denominators together. For example, one-half times three-fourths gives us three-eighths. After multiplying, we should check to see whether the answer can be reduced to simpler terms.

$$\frac{1}{2} \times \frac{3}{4} = \frac{3}{8}$$

Figure 19 Multiply Numerators (tops) and Denominators (bottoms)

Now, we can multiply a fraction by a whole number the same way. Remember that any number can be written over one. The whole number 3 can be written as three over one. Once we do that, we can multiply it just like any other fraction. So 3 times one half is three times 1 over 1 times two. That's 3 halves or one and one half.

$$\frac{3}{1} \times \frac{1}{2} = \frac{3}{2} = 1\frac{1}{2}$$

Figure 20 Mixed numbers can be re-written as improper fractions

Division is done the same way, but with an easy trick. To divide by a fraction, we turn the second fraction upside down and multiply. Turning a fraction upside down gives us what's called its "reciprocal." So if we wanted to divide ½ by 2, we would multiply 1 over two by 1 over two. It may be easy to see here that dividing by two is the same as multiplying by half.

$$\frac{1}{2} \times \frac{1}{2} = \frac{1}{4}$$

Figure 21 To divide by two, multiply by 1/2

Adding and subtracting fractions works differently. Before we can add or subtract fractions, the pieces need to be the same size. That is their denominators need to be the same. We can easily add one-fourth and two-fourths because both fractions describe fourths. One-fourth plus two-fourths equals three-fourths.

But we can't directly add one-half and one-fourth. Halves and fourths are different-sized pieces. We first need to write them using a common denominator. One-half is the same as two-fourths. Now we can add two-fourths and one-fourth to get three-fourths. We don't add the denominators because the size of the pieces hasn't changed. We are simply counting how many fourths we have.

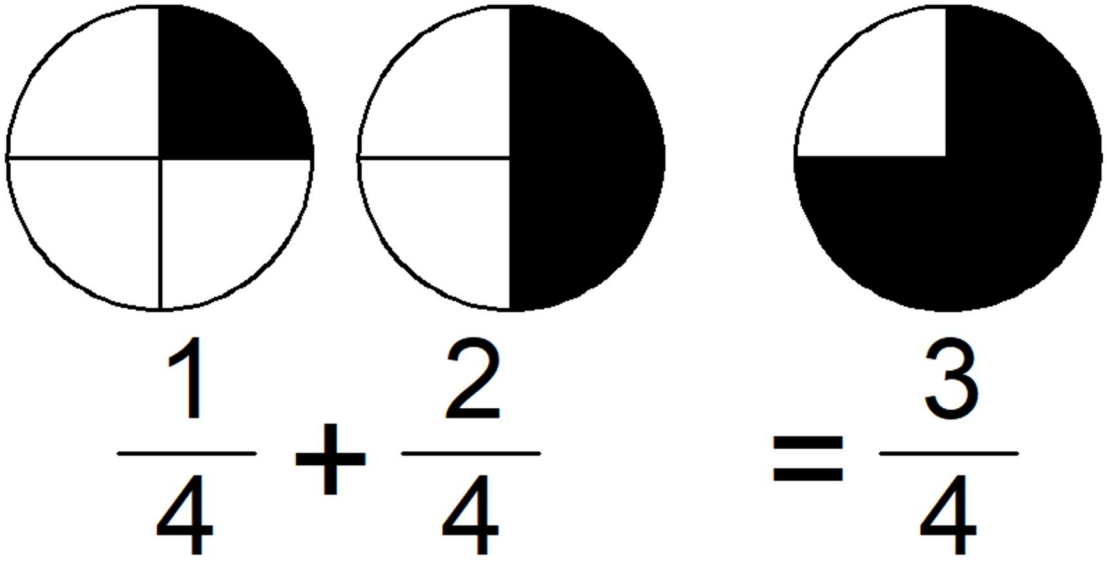


Figure 22 To add, find a common denominator

Remember that if we multiply the bottom of a fraction by some number, we need to also multiply the top. Maybe you can see that this is really a way to multiply by one, that's why the value of the fraction remains the same.

Finally, remember that a fraction is a division problem. That gives us an easy way to convert any fraction to a decimal. Divide the numerator by the denominator. Three divided by four gives us 0.75, so three-fourths and 0.75 represent the same value.

We can also express that same value as a percent. The decimal 0.75 is the same as 75 percent. We will spend more time working with percentages in another lesson. For now, just recognize that three-fourths, 0.75, and 75 percent are different ways of writing the same value.

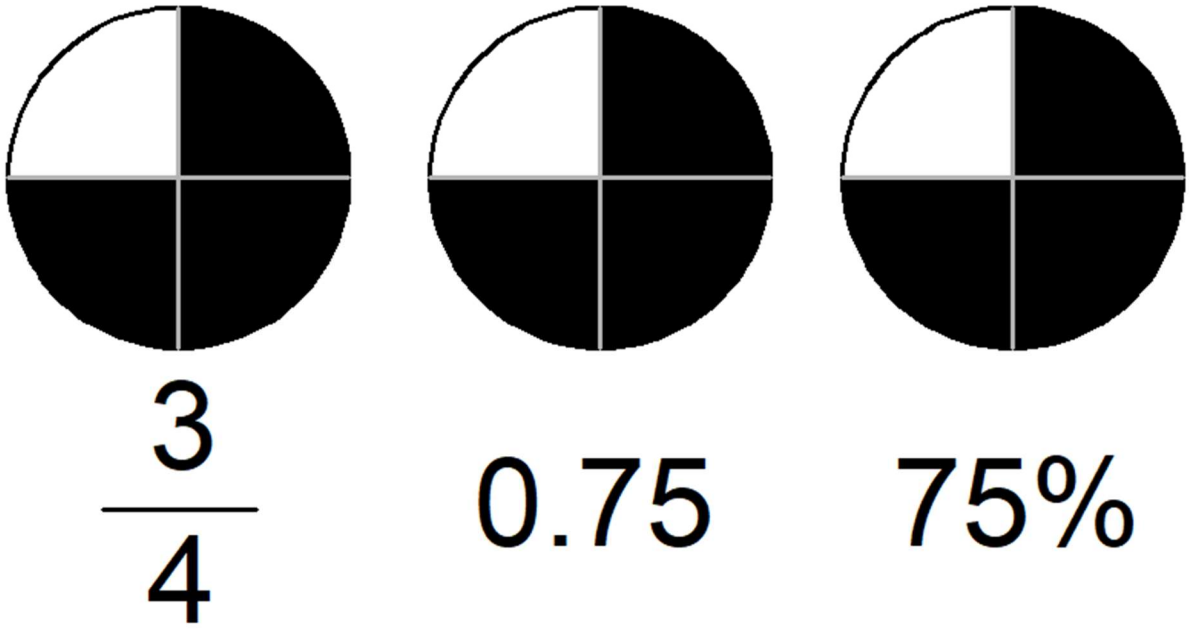


Figure 23 Different ways of writing the same value

Let's review. A fraction represents division and can describe part of a whole. Fractions can be written in different but equivalent forms, and we can simplify them when needed. When doing math with fractions, remember that the fraction bar means divided by, keep track of what the numerator and denominator represent, and make sure your answer makes sense.

Unit 3 - Review Questions

Introduction to Fractions

Name: _____ Date: _____

Directions: Select one answer for each multiple-choice question. For numerical questions, write only the requested number; the unit is given in the question. Complete each matching set by writing the letter of the correct response.

Part A — Multiple Choice

1. In the fraction 3/4, which number is the denominator?

A. 3
B. 4
C. 7
D. 12

2. What does the fraction 3/4 mean?

A. 3 multiplied by 4
B. 4 divided by 3
C. 3 divided by 4
D. 3 plus 4

3. A circle is divided into four pieces of different sizes. Which statement is correct?

A. Each piece is ¼
B. The pieces are fourths only if equal in size
C. Each piece is 4/1
D. Four pieces always make four equal fractions

4. Which fraction is greatest?

A. ½
B. ¼
C. 1/8
D. 1/16

5. Which fraction is equivalent to 6/12?

A. 1/3
B. 2/3

C. ½
D. 3/4

6. Which fraction is equal to one whole?

A. 4/5
B. 5/4
C. 5/5
D. 1/5

7. Which is an improper fraction?

A. 3/5
B. 5/4
C. ½
D. 3/4

8. Which is the correct way to multiply 1/2 by 3/4?

A. Add the numerators and denominators
B. Multiply numerator by numerator and denominator by denominator
C. Multiply only the denominators
D. Add the denominators and multiply the numerators

9. What must be true before adding two fractions by adding their numerators?

A. They must have the same denominator
B. They must have the same numerator
C. They must both be improper
D. They must both equal one

10. Which fraction is equivalent to the decimal 0.75?

A. ¼
B. ½
C. ¾
D. 4/3

Part B — Numerical Answer

11. Twelve pins are inspected and three are nonconforming. What percentage of the pins is nonconforming? Enter the number only (no % sign).

Answer: _____

12. Write 3/4 as a decimal. Enter the number only.

Answer: _____

13. Multiply 1/2 × 3/4. Enter the numerator of the answer in simplest form.

Answer: _____

14. Multiply 1/2 × 3/4. Enter the denominator of the answer in simplest form.

Answer: _____

15. Add 1/4 + 2/4. Enter the numerator of the answer in simplest form.

Answer: _____

16. Add 1/2 + 1/4. Enter the denominator of the answer in simplest form.

Answer: _____

17. Convert 5/4 to a mixed number. Enter the whole-number part.

Answer: _____

18. Divide 1/2 by 2. Enter the denominator of the answer in simplest form.

Answer: _____

Part C — Matching

19. Match each term to its meaning.

1. Numerator _____
2. Denominator _____
3. Reciprocal _____
4. Simplest form _____

Choices:

A. Top number of a fraction
B. Bottom number of a fraction
C. Fraction with numerator and denominator exchanged
D. Equivalent fraction reduced as far as possible

20. Match each fraction to an equivalent value.

1. 1/2 _____
2. 1/4 _____
3. 3/4 _____
4. 5/4 _____

Choices:

A. 0.50
B. 0.25
C. 0.75
D. 1.25

Unit 3 - Instructor Answer Key

Introduction to Fractions

Remove this page before distributing the student worksheet, if desired.

Part A — Multiple Choice

1. B — 4. The denominator is the bottom number, 4.
2. C — 3 divided by 4. A fraction represents division: 3 ÷ 4.
3. B — The pieces are fourths only if equal in size. Fourth parts must be equal-sized parts.
4. A — 1/2. With the same numerator 1, a smaller denominator means a larger fraction.
5. C — 1/2. Dividing numerator and denominator by 6 gives 1/2.
6. C — 5/5. A nonzero number divided by itself equals one.
7. B — 5/4. 5/4 has a numerator larger than its denominator.
8. B — Multiply numerator by numerator and denominator by denominator. 1×3 over 2×4 equals 3/8.
9. A — They must have the same denominator. The denominators must match so the parts are the same size.
10. C — 3/4. 3 ÷ 4 = 0.75.

Part B — Numerical Answer

11. 25. 3/12 = 1/4 = 25%.
12. 0.75. 3 ÷ 4 = 0.75.
13. 3. 1/2 × 3/4 = 3/8.
14. 8. 1/2 × 3/4 = 3/8.
15. 3. 1/4 + 2/4 = 3/4.
16. 4. 1/2 = 2/4; 2/4 + 1/4 = 3/4.
17. 1. 5/4 = 1 and 1/4.
18. 4. 1/2 ÷ 2 = 1/2 × 1/2 = 1/4.

Part C — Matching

19. 1–A, 2–B, 3–C, 4–D.

20. 1–A, 2–B, 3–C, 4–D.

Unit 4: Introduction to Percentages

What is 100 percent? You're probably familiar with the idea that 100 percent means all of something. If a car's gas tank holds 14 gallons, and there are 14 gallons of gas in the tank, we would say the tank is 100 percent full. Those 14 gallons represent 100 percent of the tank's capacity, and the fuel gauge in the car would read "Full."

VIDEO

Introduction to Percentages

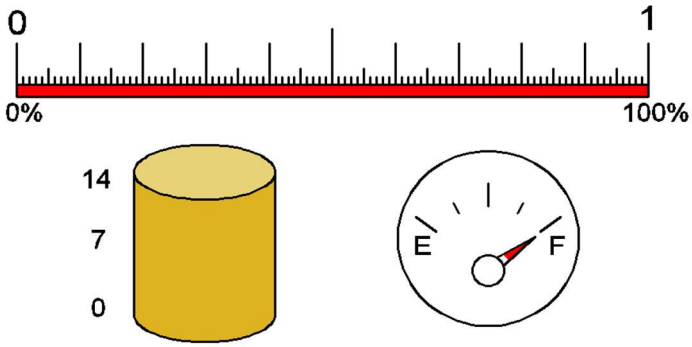


Figure 24 A full tank is 100%, not matter the size

These examples may seem so obvious that we don't question what they mean. But did you ever stop to think about why 50 percent means half of something? If we learn where percentages come from, it will be easier to solve more difficult problems. We want to be able to answer questions such as, "How much should I leave for a 15 percent tip on a 30 dollar restaurant bill?" or "23 is what percent of 50?" In manufacturing and the trades, we might need to calculate how much material to add to a mixture or determine whether a measurement falls within a specified tolerance of plus or minus 1 percent. Understanding percentages will help us solve these problems and make better decisions in everyday life and on the job.

It turns out that percentages are really just a special kind of fraction. We saw earlier that the word "per" means "for each," and that in mathematics, it means "divided by." For example, miles per hour means miles over, or divided by hours, and pounds per square inch means pounds "over" or divided by square inches.

Now, the word "cent" means one hundred. We have 100 cents in a dollar, and 100 years in a century. When we put these two words together ("per" and "cent"), "percent" literally

means “divided by (or over) one hundred.” So, a percentage is simply a fraction with a denominator of 100.

Let's start with 100 percent. We can write that as the fraction 100 over 100. Remember that any nonzero number divided by itself equals one. So, 100 percent is equal to one whole. That's why we use 100 percent to represent all of something, like a completely full gas tank.

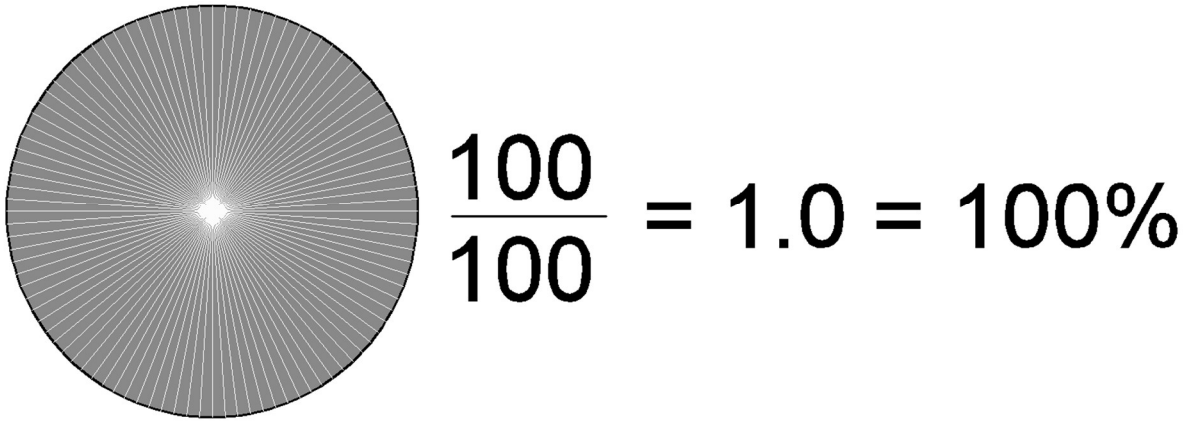


Figure 25One hundred percent is 100/100 or 1.0

Let's look at 50 percent. We can write it as the fraction 50 over 100. If we enter 50 divided by 100 into a calculator, we get 0.5. We already know that 0.5 is the same as one-half.

We can also simplify the fraction without using a calculator. Both 50 and 100 can be divided by 10, giving us 5 over 10. We can divide both of those numbers by 5, giving us 1 over 2. So, 50 over 100, 5 over 10, and 1 over 2 are all equivalent fractions. They represent the same amount: one-half, is equal to 50 percent, which is equal to .50.

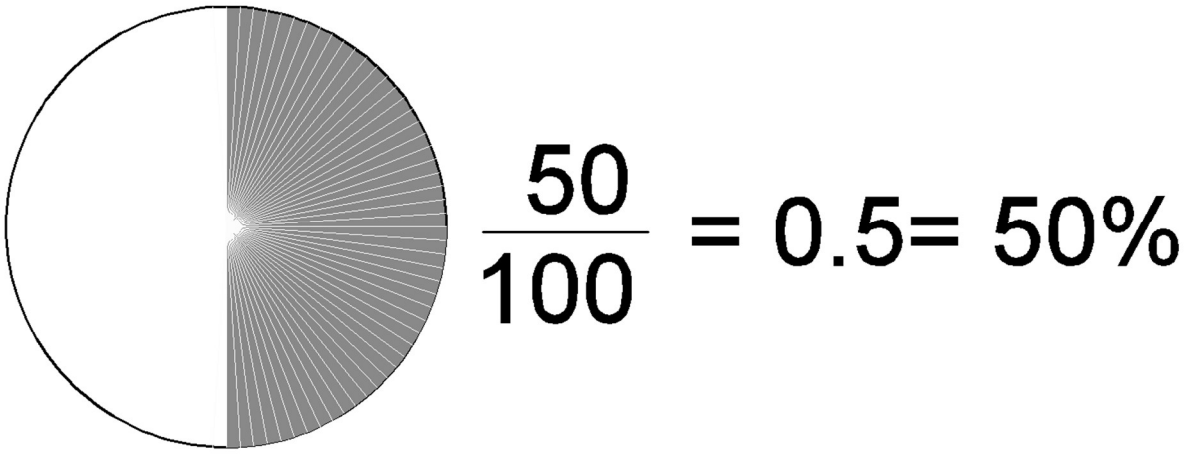
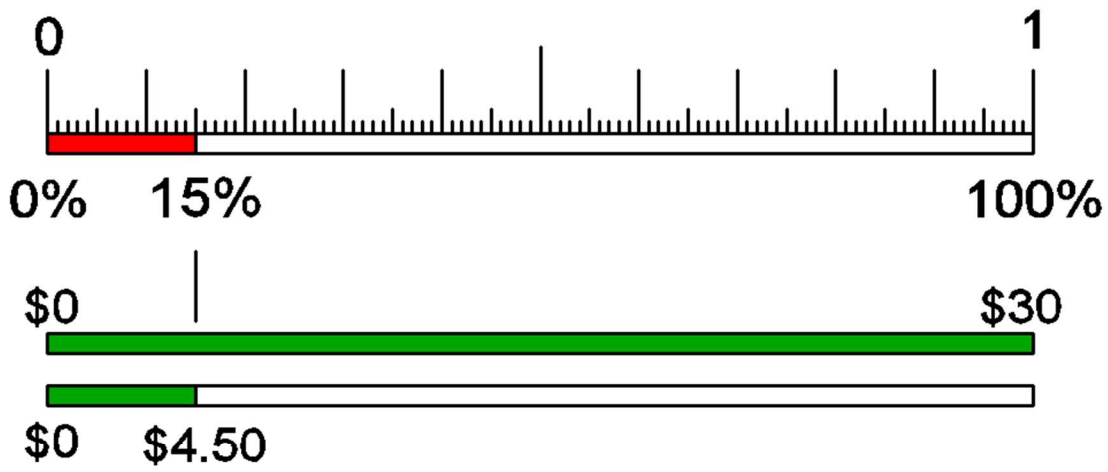


Figure 26 50% is half

We have seen that fractions that are equal can be written different ways. For instance, ¼ is equal to 2/8 which is equal to 4/16 and so on. We can keep increasing the denominator and dividing until we get to 100. When we divide a thing up into one hundred pieces, we are talking about percentages.

Now that we understand what percentages represent, let's use them to solve a problem. Suppose we have a restaurant bill for 30 dollars, and we want to leave a 15 percent tip. How much should we leave?

First, we need to find 15 percent of 30 dollars. Remember that percent means divided by one hundred. So, 15 percent is the same as 15 divided by 100, which gives us the decimal 0.15. We can multiply 30 dollars by 0.15 and get 4 dollars and 50 cents. That's the amount of our tip.



$$0.15 * \$30 = \$4.50$$

Figure 27 15% of something is .15 times the amount

In the same way that 7 gallons was 50 percent of our 14 gallon tank, 4 dollars and fifty cents is 15% of 30. 4 fifty divided by 30 equals zero point 15 or 15/100.

If we wanted to find the total amount we would pay, including the tip, we would simply add 4 dollars and 50 cents to the original 30 dollars. Our total would be 34 dollars and 50 cents.

Notice that we used the decimal form of the percentage to make the calculation. This is a useful method to remember. To find a percentage of an amount, divide the percentage by 100, then multiply the result by the amount. For example, 5 percent becomes 0.05, and 1 percent becomes 0.01.

It is actually very easy to divide by one hundred. Take 15 for example. If we divide 15 by ten we get 1.5. We just move the decimal place over. If we divide by ten again, we get 0.15. Dividing by ten twice is the same thing as dividing by one hundred. So, to convert a percent, like 15 into a decimal, we just move the decimal place over two places.

Sometimes, instead of finding a percentage of an amount, we want to find out what percentage one quantity represents of another. Let's look at these 100 pins. Suppose 23 of them have been identified as nonconforming, meaning they do not meet the requirements.

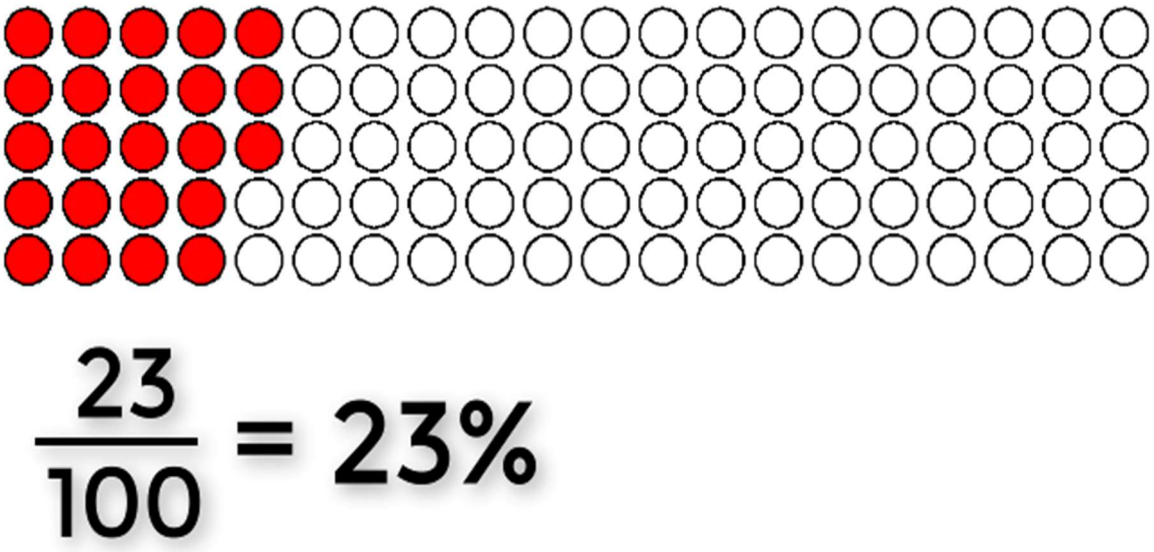


Figure 28 23 out of 100 is 23%

We have 23 nonconforming parts out of 100 total parts. We can write that as the fraction 23 over 100. Dividing 23 by 100 gives us 0.23. To change that decimal into a percentage, we multiply by 100. So, 23 percent of our parts are nonconforming.

But what if we had a different number of parts? Suppose we inspected 50 parts and found that, like before, 23 were nonconforming. We would divide 23 by 50, which gives us 0.46. Multiplying by 100 gives us 46 percent. Notice that the number of nonconforming parts is the same, but the percentage is different because the total number of parts has changed.

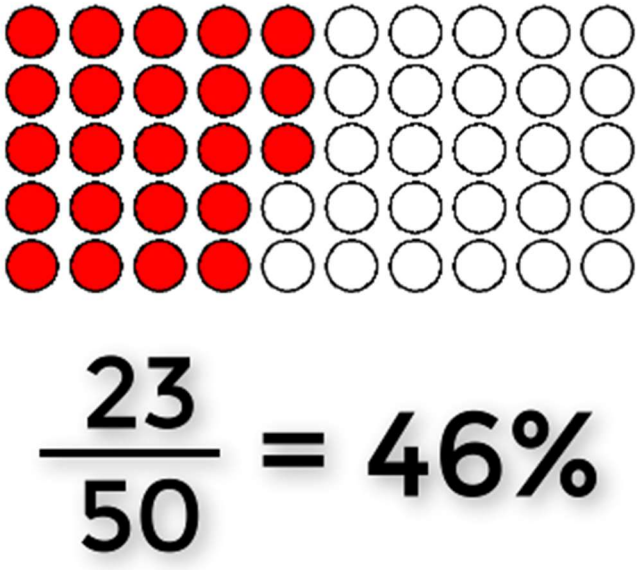


Figure 29 23 out of 50 is 46% (23/50)

This is an important idea. A percentage always refers to some particular whole. Before doing a percentage calculation, make sure you know what quantity represents the total.

Now let's look at a practical application in manufacturing and the trades. Many measurements and quantities must fall within an acceptable range. We call this range a tolerance.

Suppose a process calls for 200 pounds of material, with a tolerance of plus or minus 1 percent. This means the actual amount can be as much as 1 percent above or 1 percent below the target of 200 pounds.

First, let's find 1 percent of 200 pounds. One percent is 0.01, so we multiply 200 pounds by 0.01. The answer is 2 pounds. That means we can have 2 pounds more or 2 pounds less than our target and still be within tolerance.

To find the lower limit, subtract 2 pounds from 200 pounds. That gives us 198 pounds. To find the upper limit, add 2 pounds to 200 pounds. That gives us 202 pounds. Our acceptable range is from 198 to 202 pounds.

Now suppose we measure 201.5 pounds. That's between our lower and upper limits, so the measurement is acceptable. But if we measure 203 pounds it would be above the upper limit, so the measurement would be outside the tolerance.

Now, there is a simple trick we can use to calculate these limits a little faster, and it will save us a step. Remember that our original target represents 100 percent. If we allow 1

percent above the target, that gives us 101 percent of the original amount. One hundred and one percent is 1.01 as a decimal.

So, instead of finding 1 percent and adding it to the target, we can simply multiply 200 pounds by 1.01. That gives us the same upper limit of 202 pounds.

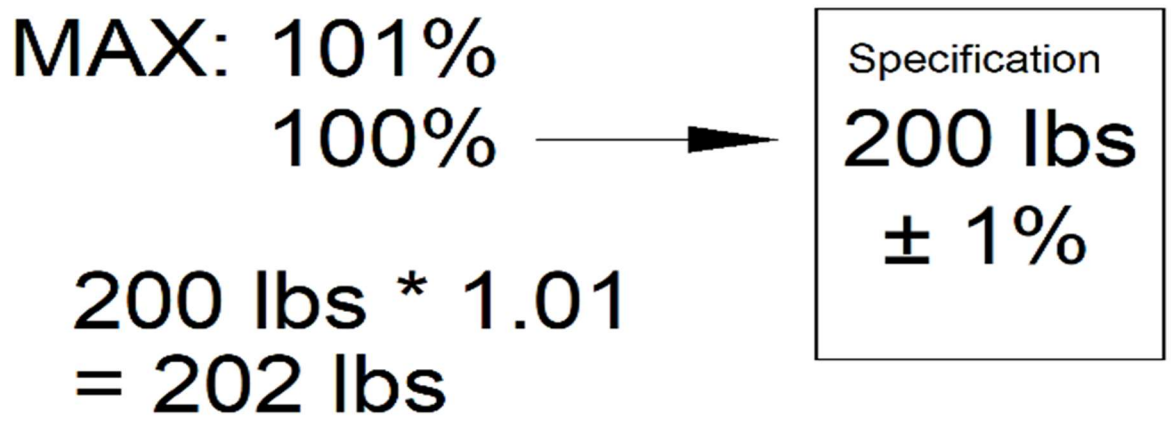


Figure 30 Multiply by 101% instead of adding one percent to 100%

For the lower limit, we subtract 1 percent from 100 percent, leaving 99 percent. Ninety-nine percent is 0.99 as a decimal. Multiplying 200 pounds by 0.99 gives us 198 pounds, our lower limit.

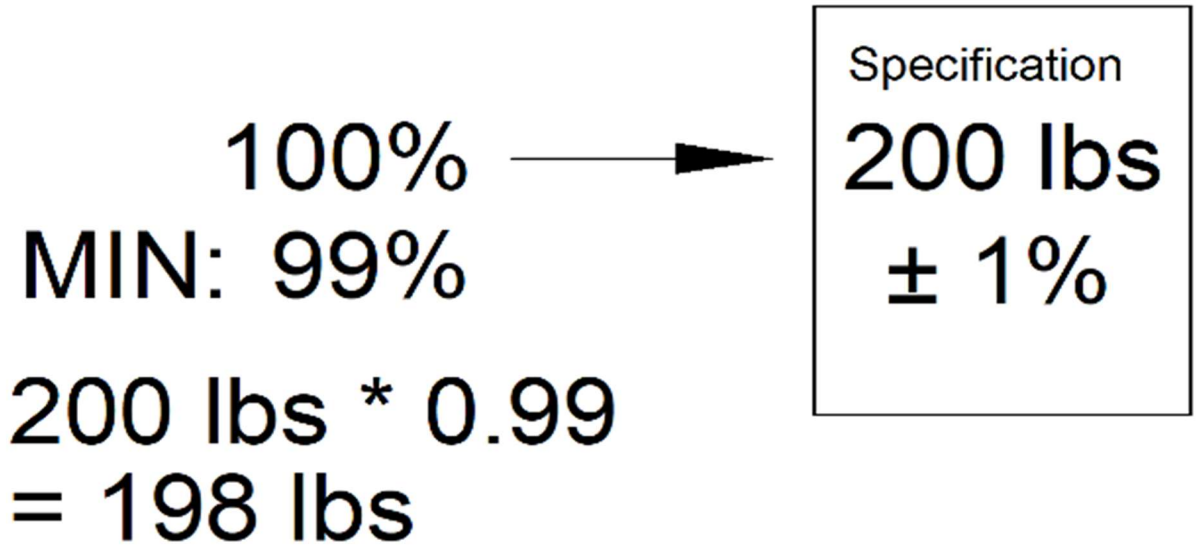


Figure 31Multiply by .99 instead of subtracting 1% from 100%

Keep in mind that 1 percent does not always represent the same quantity. One percent of 200 pounds is 2 pounds, but 1 percent of 50 pounds is only half a pound. The percentage is the same, but the actual amount depends on the quantity we started with.

Let's review. Percent means divided by one hundred, and percentages can be converted to other fractions or decimals. We can use them to find part of an amount, compare quantities, and calculate acceptable limits. The important thing is to know what the percentage is based on and make sure our answer makes sense.

Unit 4 – Review Questions

Introduction to Percentages

Name: _____ Date: _____

Choose the best answer or write the requested numerical value. Show your work when helpful.

Part A — Multiple Choice

1. A fuel tank is completely full. What percentage of its capacity does it contain?

A. 25%
B. 50%
C. 75%
D. 100%

2. Which fraction represents 50%?

A. ¼
B. ½
C. ¾
D. 1/5

3. Which decimal is equivalent to 15%?

A. 0.015
B. 0.15
C. 1.5
D. 15.0

4. A shop inspects 100 pins and finds 23 defective. What percentage is defective?

A. 2.3%
B. 23%
C. 46%
D. 77%

5. A shop inspects 50 pins and finds 23 defective. What percentage is defective?

A. 23%
B. 35%
C. 46%
D. 50%

6. A 14-gallon tank is half full. Approximately how many gallons are in it?

A. 3.5
B. 7
C. 10.5
D. 14

7. Which expression finds 15% of a $30 restaurant bill?

A. 30 × 0.15
B. 30 × 1.15
C. 30 ÷ 0.15
D. 30 + 15

8. A specification allows a weight of 200 lb ±1%. Which range is acceptable?

A. 199–201 lb
B. 198–202 lb
C. 190–210 lb
D. 180–220 lb

9. Which multiplier gives a value 1% ABOVE its starting amount?

A. 0.01
B. 0.99
C. 1.01
D. 1.10

10. Which multiplier gives a value 1% BELOW its starting amount?

A. 0.01
B. 0.90
C. 0.99
D. 1.01

Part B — Numerical Answers

11. What is 25% of 80 bolts? Enter the number of bolts.

Answer: _____

12. What is 10% of 250 pounds? Enter the number of pounds.

Answer: _____

13. A $40 meal has a 15% tip. What is the tip in dollars?

Answer: _____

14. A batch has 12 rejected parts out of 60. What percentage is rejected? Enter the number without the % sign.

Answer: _____

15. A container holds 14 gallons when full. It is 75% full. How many gallons does it hold?

Answer: _____

16. A 300-pound load has a tolerance of ±2%. How many pounds is the tolerance on either side?

Answer: _____

17. What is the upper acceptable weight, in pounds, for a 300-pound load with a ±2% tolerance?

Answer: _____

18. A part weighs 150 pounds. Its weight increases by 1%. What is its new weight in pounds?

Answer: _____

Part C — Matching

19. Match each percentage with its decimal.

1. 25% _____
2. 50% _____
3. 75% _____
4. 1% _____

Choices: A. 0.75 B. 0.25 C. 0.01 D. 0.50

20. Match each expression with its meaning.

1. Amount × 0.15 _____
2. Amount × 1.01 _____

3. Amount × 0.99 _____
4. Part ÷ total × 100 _____

Choices: A. Amount decreased by 1% B. 15% of the amount C. Percentage represented by the part D. Amount increased by 1%

Unit 4 – Instructor Answer Key

Unit 4 – Introduction to Percentages

Part A — Multiple Choice

1. D — 100%. A full tank contains 100% of its capacity.
2. B — 1/2. 50/100 simplifies to 1/2.
3. B — 0.15. 15% means 15/100 = 0.15.
4. B — 23%. 23 out of 100 is 23%.
5. C — 46%. 23 ÷ 50 × 100 = 46%.
6. B — 7. Half of 14 gallons is 7 gallons.
7. A — 30 × 0.15. Multiply the bill by 0.15 to find the tip alone.
8. B — 198–202 lb. 1% of 200 lb is 2 lb.
9. C — 1.01. 100% + 1% = 101% = 1.01.
10. C — 0.99. 100% − 1% = 99% = 0.99.

Part B — Numerical Answers

11. 20. 0.25 × 80 = 20 bolts.
12. 25. 0.10 × 250 = 25 pounds.
13. 6. 0.15 × $40 = $6.
14. 20. 12 ÷ 60 × 100 = 20%.
15. 10.5. 0.75 × 14 = 10.5 gallons.
16. 6. 0.02 × 300 = 6 pounds.
17. 306. 300 + 6 = 306 pounds.
18. 151.5. 150 × 1.01 = 151.5 pounds.

Part C — Matching

19. 1 → B; 2 → D; 3 → A; 4 → C
25% = 0.25; 50% = 0.50; 75% = 0.75; 1% = 0.01
20. 1 → B; 2 → D; 3 → A; 4 → C

Amount × 0.15 = 15% of the amount; Amount × 1.01 = Amount increased by 1%; Amount × 0.99 = Amount decreased by 1%; Part ÷ total × 100 = Percentage represented by the part

Unit 5: Ruler Fractions

There's a simple pattern behind the marks on a measuring tape or ruler. Once you understand that pattern, taking measurements becomes much easier.

VIDEO

Ruler Fractions

Let's start with one inch. An inch is a unit of length that's a little bit bigger than a US quarter. It's about the width of my thumb. Most rulers divide inches into smaller, equal parts. On most rulers and measuring tapes, we use fractions to describe those parts.

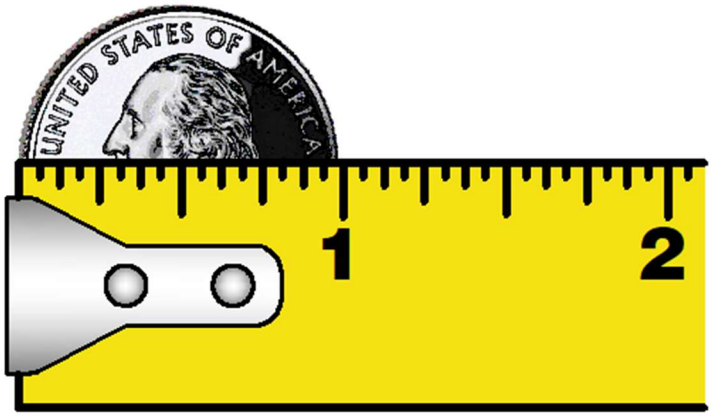


Figure 32 An inch is a little bigger than a US quarter

Now, let's divide an inch into two equal pieces. Each piece is one-half of an inch. The mark in the middle identifies the halfway point, or one-half inch. The numerator (on top) is one, because we have one part, and the denominator (on the bottom of the fraction) is two, because the inch has been divided into two pieces.

If we have one "half", we have one of the two equal pieces of the inch.

Suppose we divide each of the halves in half. We now have four equal pieces, and each piece is one fourth, or one-quarter of an inch. Two of these quarters are equal to one-half. Notice that the fraction 2 over four can be simplified to one half. We generally talk about ruler fractions in lowest terms like this, but you can worry about this later, once you get used to how the scale works.

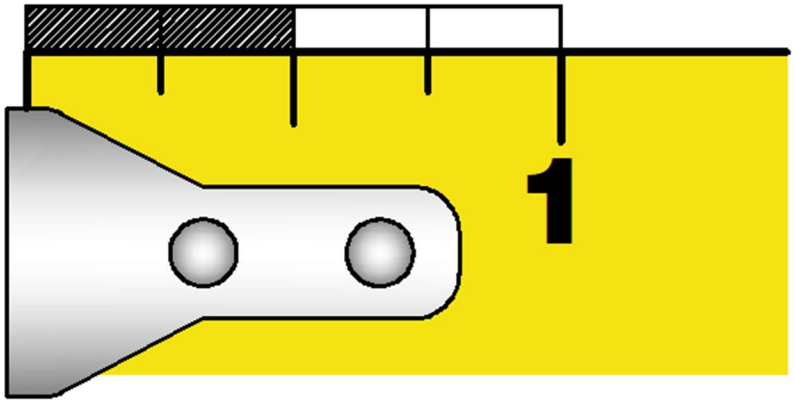


Figure 33 Two quarters equals one half

We can now divide each of the quarters in half. When we do this, we will have eight equal pieces, called “eighths.” If we divide each eighth in half again, we'll have sixteen equal pieces, called sixteenths.

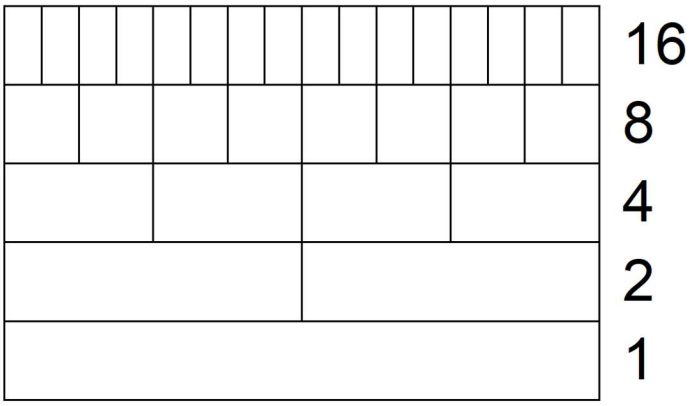


Figure 34 Ruler fractions follow a pattern.

Each time we divide the pieces in half, we double the number of pieces, and each individual piece becomes smaller.

This is how the markings on a typical inch measuring tape are organized. We have whole inches, halves, quarters, eighths, and sixteenths. Some measuring instruments have even smaller divisions, but sixteenths are common on measuring tapes.

Now let's look at an actual measuring tape. The longest marks with the numbers identify the whole inches. Halfway between two whole-inch marks, we'll find another long mark. That's the half-inch mark.

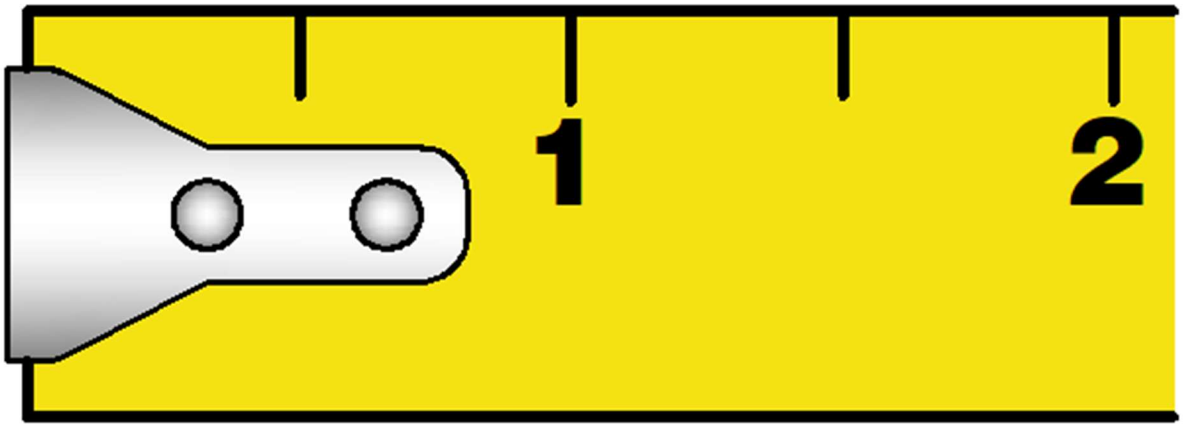


Figure 35 Whole and half inches

In between each half inch mark are the quarter inch marks. These are a little shorter. Let's look at the quarter inches. The first one is one-quarter, two quarters would be the same as one half, so we generally call it a half. Then three quarters, and finally, four quarters would be a whole inch.

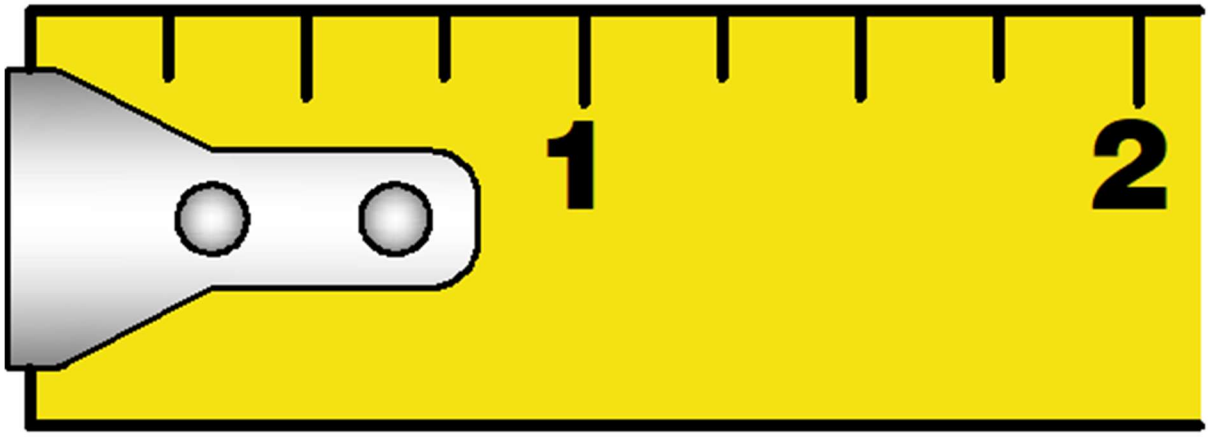


Figure 36 Quarter inch marks

Here's a mistake that some people make when starting out. If we count the marks instead of the spaces, we will get the wrong answer. Starting at zero, we don't count the zero mark as one. We count the first space as one-quarter, the second as two-quarters, and so on. Just be sure you are counting the spaces, and not the marks, and you'll be fine.

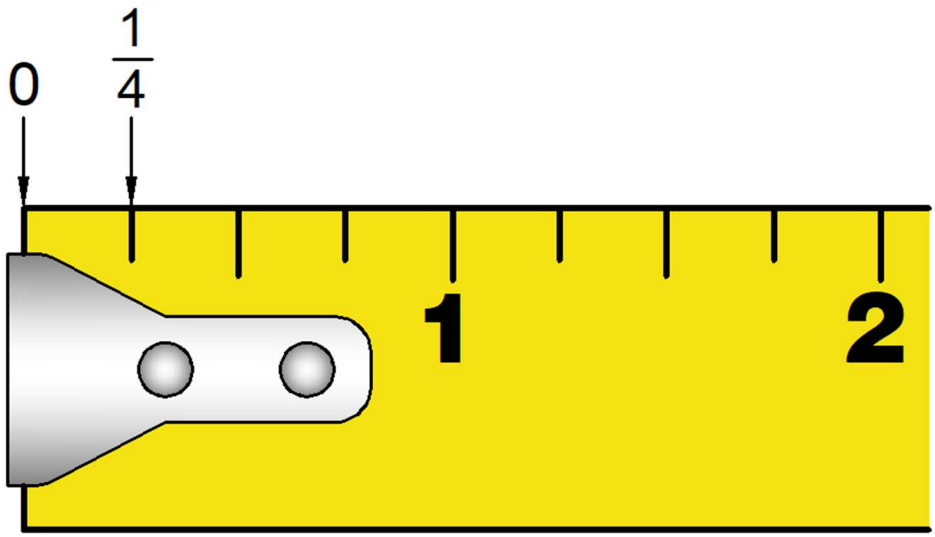


Figure 37 The end of the tape is zero

If we look between the quarter-inch marks, we'll see the eighth-inch marks. Let's look quickly at those. Here is one eighth, now, two eighths is the same as one quarter, then three eighths, one half is where the fourth eighth falls, then five eighths, six eighths is three quarters, "seven" eighths, and finally eight eighths is the next whole inch.

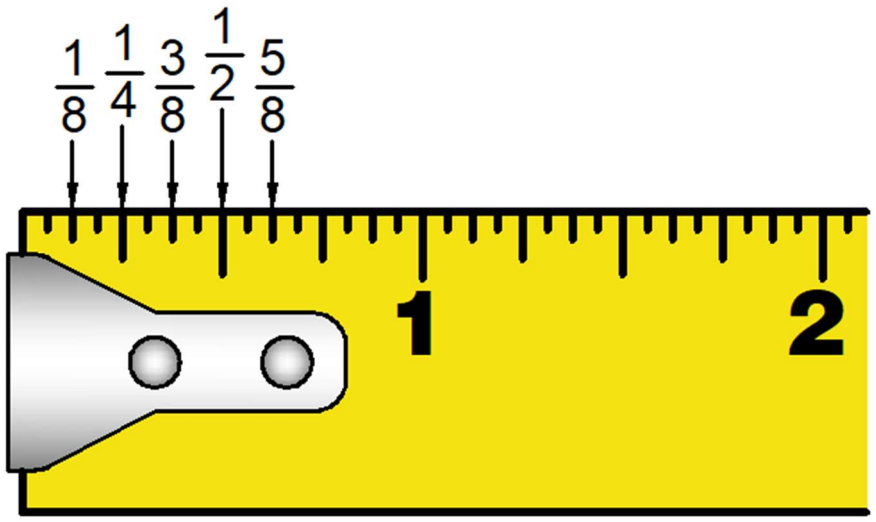


Figure 38 Eighths of an inch. Notice overlap with quarters and half.

Shortest of all on this tape are the sixteenth marks. You may have noticed that if we put our fractions in simplest form, we always wind up with an odd number on top (that is, the numerator). Let's look at the sixteenths in a little more detail, and I'll show you how that happens.

First is one sixteenths. One is odd, and it is in simplest form. Now, the next sixteenth would be two sixteenths, but because two and sixteen are both even, we can divide by two. That gives us one over eight. We saw one eight just a minute ago. Now three sixteenths, that's in simplest form. Four sixteenths can be divide by two to get 2 eighths, and 2 eighths can be divided by two to leave one quarter. Five sixteenths, six sixteenth is three eighths, seven sixteenths, and eight sixteenths can be divided all the way to one half.

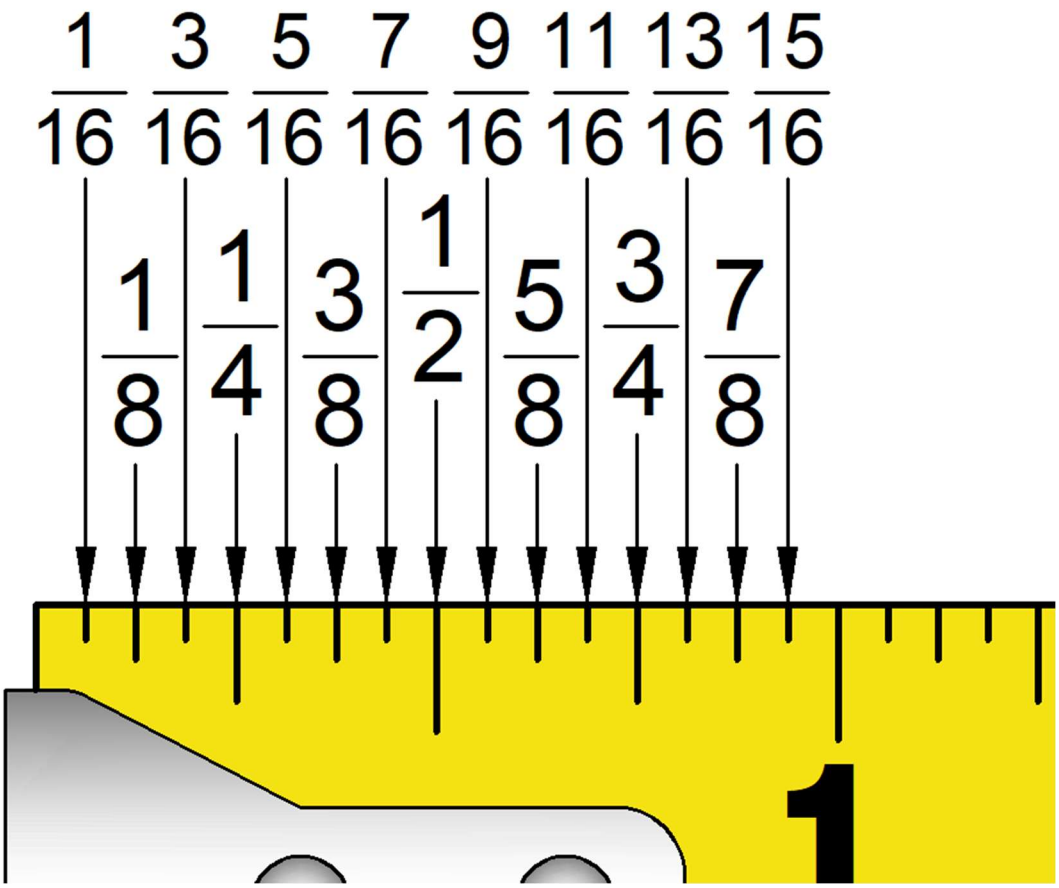


Figure 39 All reduced ruler fractions have odd numerators (top numbers)

This reminds me of a simple trick to find measurements that are beyond the half inch mark. Let's look at this mark, it is the shortest line on the ruler, and we can count eight of them to the halfway mark, so we know that there would be sixteen in an inch. Now, because 8 is half of sixteen, we can start at the half inch mark and count eight, nine, ten, eleven. This measurement is 11 sixteenths.

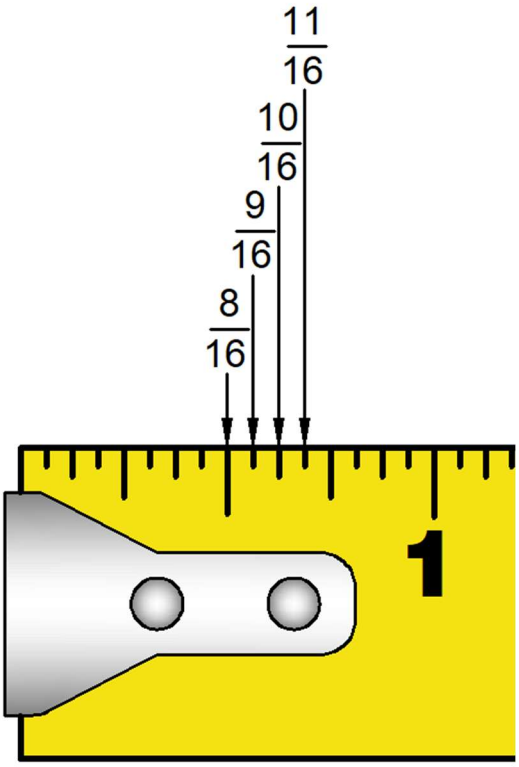


Figure 40 Counting up from one half (8/16)

Here's another way to make counting sixteenths easier. Let's look at this mark. Again, we can see that it is a sixteenth of an inch. Because there are sixteen, we can start at the next whole inch mark and count down from sixteen. Sixteen, fifteen, fourteen, and now thirteen. So this measurement is 13 sixteenths. That's about the hardest mark to read, but when we use this trick, it's not too bad.

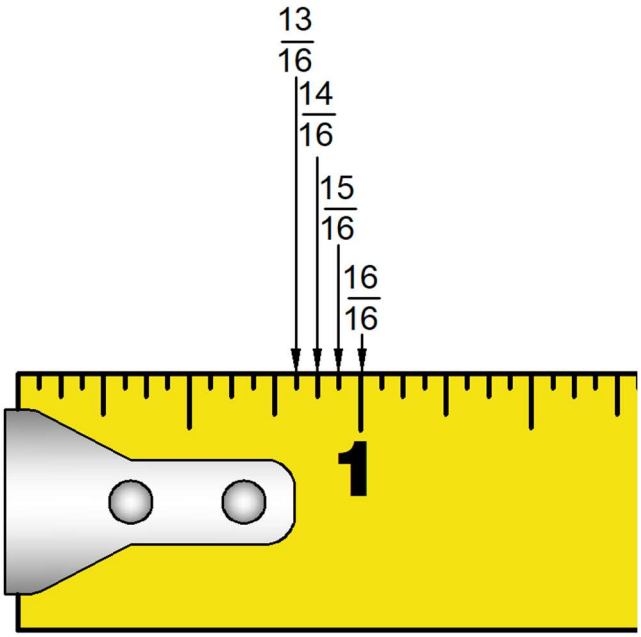


Figure 41 Counting back from whole inch (16/16)

Now, let's practice taking some measurements. Let's start with an easier one. This is one quarter or one fourth of an inch. Notice that if we count the sixteenths, we have one, two, three, four of them. 4 sixteenths is equal to 2 eights, which is equal to 1 quarter. If our numerator is even, we need to divide by two until it is odd. That way we will have our fraction in lowest terms.

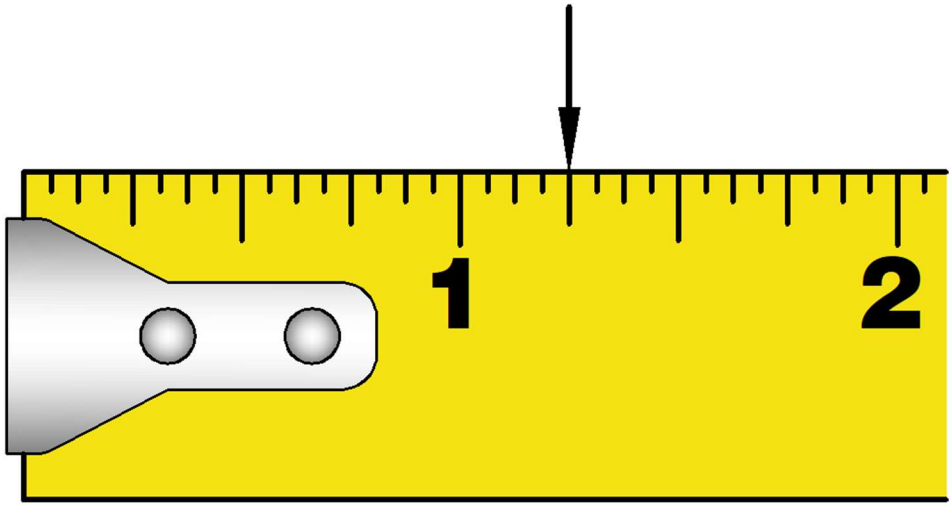


Figure 42 This reading is 1 1/4

Here's a more difficult one.... The answer is seven eighths. If we recognize that the mark is an eighth of an inch, we can start at the next whole inch and count back from eight eighths. So our answer is seven eighths.

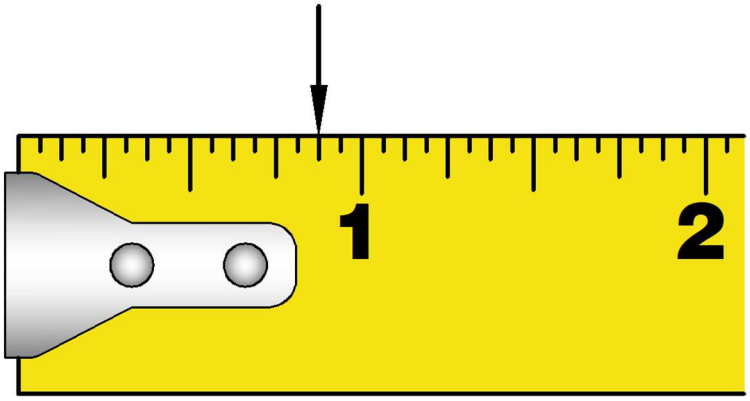


Figure 43 This reading is 7/8

If you got those right, we can try a harder one. This one is very close to the half inch mark, but it's a little bit less. Pause the video and take some time to work it out. The answer is 7 sixteenths. We can count the sixteenths individually, one, two, three, four, five, six, seven... When we get used to it, we can start at 8 sixteenths and count back one. Use the scale however it works for you. With more practice, it will get easier and easier.

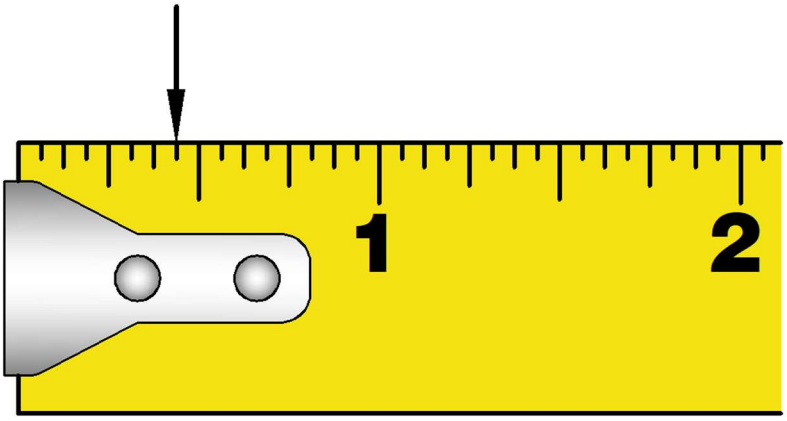


Figure 44 Try reading back from 8/16 (reading is 7/16)

So, let's review. An inch can be divided into halves, quarters, eighths, and sixteenths. The different lengths of the marks help us recognize those divisions. And when we need to find an unfamiliar fraction, we can start at a familiar mark and count forward or backward.

Remember to count the spaces, not the marks. Take your time and practice, and before long, reading a measuring tape or a ruler will become second nature.

Unit 5 – Review Questions

Ruler Fractions

Name: _____ Date: _____

Choose the best answer or enter the requested number. Use the spaces below numerical problems to show your work.

Part A — Multiple Choice

1. On a typical inch measuring tape divided into sixteenths, what does the longest numbered mark indicate?

A. A whole inch
B. One-half inch
C. One-quarter inch
D. One-sixteenth inch

2. How many equal quarter-inch spaces make one inch?

A. 2
B. 4
C. 8
D. 16

3. What fraction is equivalent to 2/4 inch in lowest terms?

A. 1/8
B. ¼
C. ½
D. 3/4

4. Which fraction describes the mark halfway between 0 and 1/2 inch?

A. 1/8
B. ¼
C. 3/8
D. 3/4

5. A tape is divided into sixteenths. Which mark is at the same location as 6/16 inch?

A. 1/4 inch
B. 3/8 inch

C. 1/2 inch
D. 5/8 inch

6. Which measurement is immediately before 1/2 inch on a tape marked in sixteenths?

A. 3/8 inch
B. 7/16 inch
C. 9/16 inch
D. 5/8 inch

7. Which fraction is already in lowest terms?

A. 2/16
B. 4/16
C. 6/16
D. 7/16

8. When reading a ruler from zero, what should you count to determine the fractional distance?

A. The spaces between marks
B. The marks including zero
C. Only the numbered marks
D. Only the longest marks

9. A mark is three sixteenth-inch spaces before the next whole inch. What is the measurement from zero within that inch?

A. 11/16 inch
B. 12/16 inch
C. 13/16 inch
D. 15/16 inch

10. On a typical inch tape, which fractional marks are shortest?

A. Half-inch marks
B. Quarter-inch marks
C. Eighth-inch marks
D. Sixteenth-inch marks

Part B — Numerical Answers

11. An inch is divided into eighths. How many equal spaces are there in 3/4 inch?

Answer: _____

12. A tape is divided into sixteenths. How many sixteenth-inch spaces are in 1/2 inch?

Answer: _____

13. A mark is at 5/16 inch. What is its numerator when written in sixteenths?

Answer: _____

14. A mark is 2/16 inch from zero. Reduce the fraction to lowest terms and enter its denominator.

Answer: _____

15. Starting at the 1/2-inch mark, count forward three sixteenth-inch spaces. Enter the numerator of the measurement in sixteenths.

Answer: _____

16. Starting at the 1-inch mark, count backward five sixteenth-inch spaces. Enter the numerator of the measurement in sixteenths.

Answer: _____

17. A measurement is 3/8 inch. How many sixteenth-inch spaces is that?

Answer: _____

18. An inch is divided in half four times. How many equal spaces does it contain?

Answer: _____

Part C — Matching

19. Match each fraction to its equivalent fraction.

1. 1/2 _____
2. 1/4 _____
3. 3/8 _____
4. 3/4 _____

Choices: A. 6/16 B. 8/16 C. 12/16 D. 4/16

20. Match each ruler division to the number of equal spaces in one inch.

1. Halves _____
2. Quarters _____
3. Eighths _____
4. Sixteenths _____

Choices: A. 4 B. 16 C. 2 D. 8

Unit 5 – Instructor Answer Key

Ruler Fractions

Part A — Multiple Choice

1. A — A whole inch. The numbered marks identify whole inches.
2. B — 4. Four quarters make one whole inch.
3. C — 1/2. Dividing numerator and denominator by 2 gives 1/2.
4. B — 1/4. Half of 1/2 inch is 1/4 inch.
5. B — 3/8 inch. 6/16 simplifies to 3/8.
6. B — 7/16 inch. One-sixteenth less than 8/16 is 7/16.
7. D — 7/16. 7 and 16 have no common factor greater than 1.
8. A — The spaces between marks. Each space represents a length; counting zero as a space produces an error.
9. C — 13/16 inch. 16/16 minus 3/16 equals 13/16.
10. D — Sixteenth-inch marks. Sixteenth-inch marks are the shortest among these divisions.

Part B — Numerical Answers

11. 6. 3/4 = 6/8, so there are six eighth-inch spaces.
12. 8. 1/2 = 8/16.
13. 5. The numerator of 5/16 is 5.
14. 8. 2/16 = 1/8, so the denominator is 8.
15. 11. 1/2 = 8/16; 8/16 + 3/16 = 11/16.
16. 11. 16/16 − 5/16 = 11/16.
17. 6. 3/8 = 6/16.
18. 16. Repeated halving gives 2, 4, 8, then 16 spaces.

Part C — Matching

19. 1–B; 2–D; 3–A; 4–C

1/2 = 8/16; 1/4 = 4/16; 3/8 = 6/16; 3/4 = 12/16

20. 1–C; 2–A; 3–D; 4–B

Halves = 2; Quarters = 4; Eighths = 8; Sixteenths = 16

Math with Ruler Fractions

In manufacturing and the skilled trades, we often need to add and subtract measurements expressed as fractions. Fortunately, the fractions found on rulers and measuring tapes are a little easier to work with than some of the fractions you may have encountered in school. That's because the bottom numbers (the denominators) are usually two, four, eight, or sixteen. And those numbers work together in a very convenient way.

VIDEO

Math with Ruler Fractions

Let's look at an example. Suppose we have made marks on pieces of bar stock at 12 and one-quarter inches. The foreman says that a design change means the bars need to be three-eighths of an inch longer than that. To find the place where the new mark goes, we will need to add three-eighths to 12 and one-quarter.

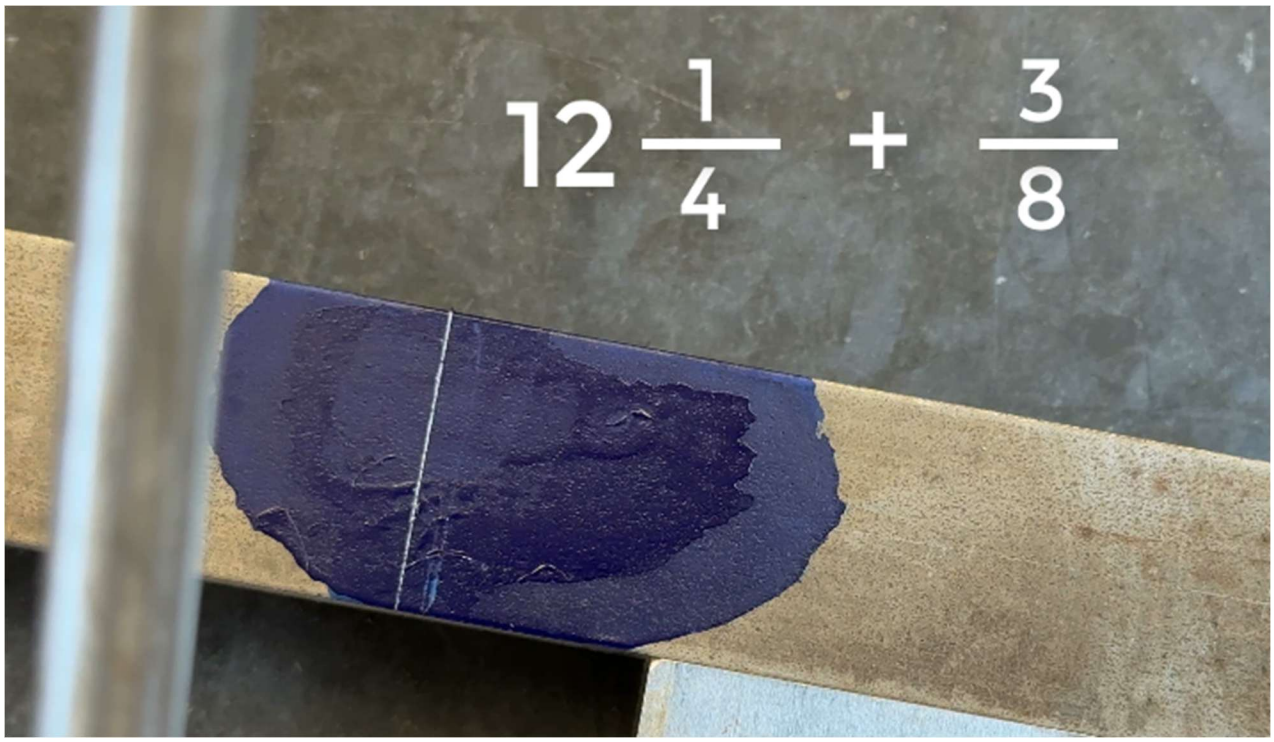


Figure 45 A typical ruler fraction problem

Let's just look at the fractions first. We can't directly add three-eighths and one-quarter inch. These represent different-sized pieces of an inch. We need to find what is called a

common denominator. That is, the bottom part of the fraction needs to be the same for both fractions. Now, because these are ruler fractions, this won't be too hard.

Notice that four is half of eight. If both fractions had eight in the denominator, the bottom, we could add them. We simply double the top and bottom of the quarter-inch fraction. We get two-eighths. Remember, we can double both the top and bottom numbers without changing the value of the fraction. One-quarter and two-eighths represent exactly the same length.

Now we can add three-eighths and two-eighths to get five-eighths. Add that to the 12 inches, and we will place our new mark at 12 and five-eighths inches.

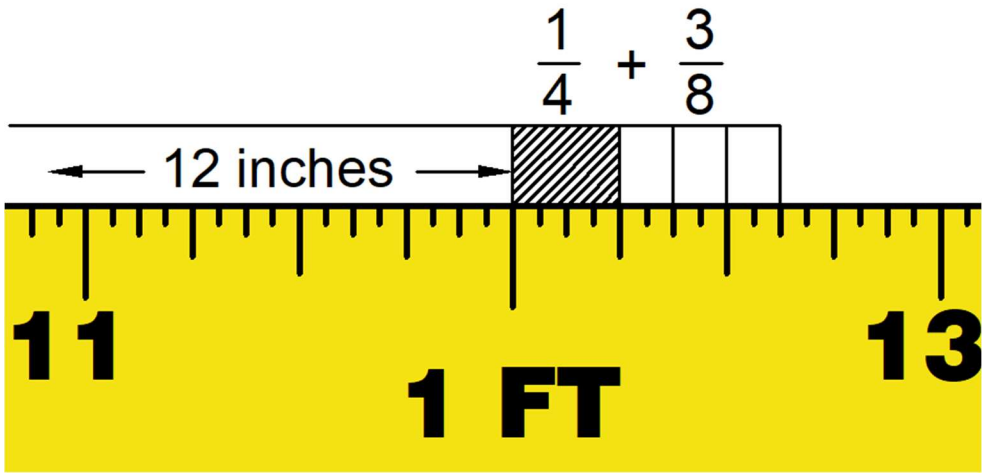


Figure 46 1/4 can be converted to 2/8

Finding a common denominator for ruler fractions usually means we just double one of the fractions, on top and on bottom. Now, we may need to double more than once, but that's usually not too hard because the denominators are always numbers like 2, 4, 8, 16, and sometimes 32. Here's an example of a harder one.

A manifold is 2 and one-quarter inches tall. If we add a gasket that is one-sixteenth of an inch thick below the manifold, how tall will the assembly be? Again, we can't just add a sixteenth to a quarter. We need to convert the quarter inch to sixteenths. If we double the top and bottom, we get two-eighths. Doubling again gives us four-sixteenths. Now that we have sixteenths in both fractions, we can simply add. Four-sixteenths plus one-sixteenth is five-sixteenths. So the overall height of the assembly is now 2 and five-sixteenths inches.

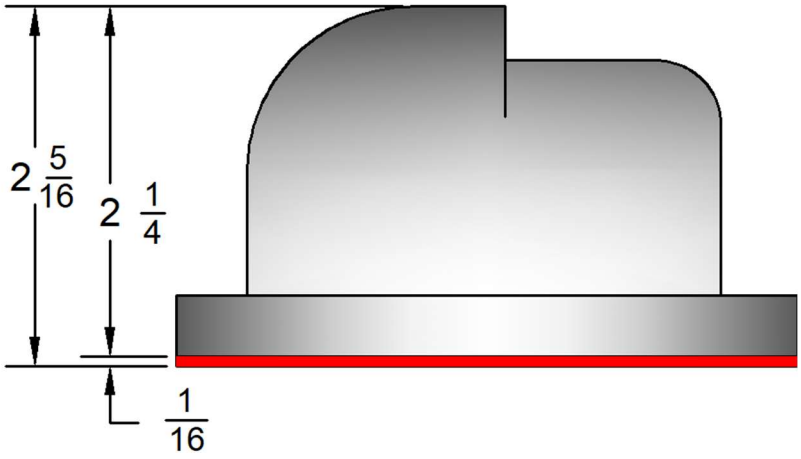
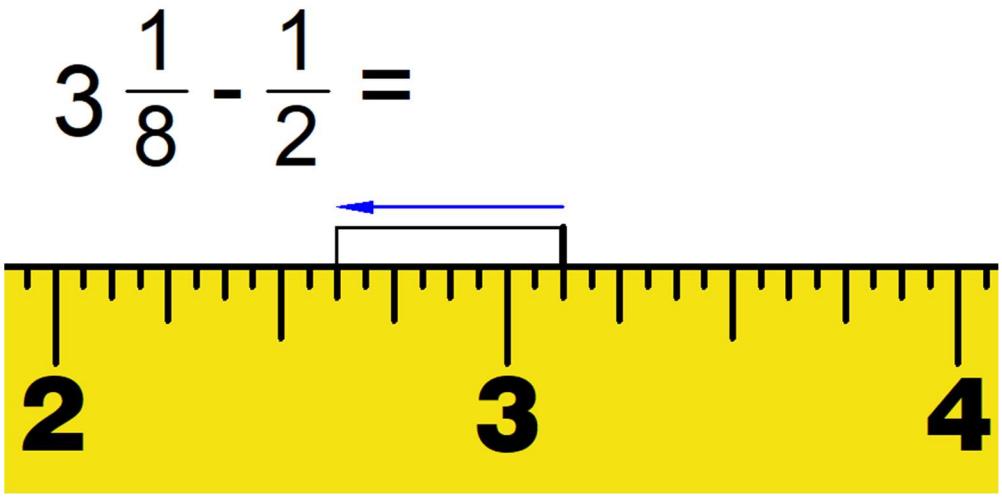


Figure 47 Adding 1/16 to 2 1/4

Subtracting fractions works the same as addition, except we may need an extra step. For example, what is 3 and one-eighth minus one-half? First, let's look at the fractional part. We need to convert the half to eighths. We double once to get two-fourths, then again to get four-eighths.

We can't subtract four-eighths from one-eighth without getting a negative fraction. But we can take one of our three whole inches and exchange it for eight-eighths. That leaves us with two whole inches, plus eight-eighths and one-eighth.

Now we add those fractions. Eight-eighths plus one-eighth is nine-eighths. Nine-eighths minus four-eighths is five-eighths. Our answer is two and five-eighths inches.



Sometimes when adding fractions, we may wind up with an answer larger than an inch. For instance, let's add five-eighths and three-quarters. Convert the three-quarters to eighths by doubling the top and bottom. That's six-eighths. Six-eighths plus five-eighths is eleven-eighths.

That's more than one whole inch. Now, keep in mind that a number divided by itself is equal to one, so eight-eighths makes one whole inch. We can take eight of our eleven eighths and make one whole inch, leaving three eighths. So our answer is one and three-eighths inches.

$$\frac{5}{8}+\frac{6}{8}=$$

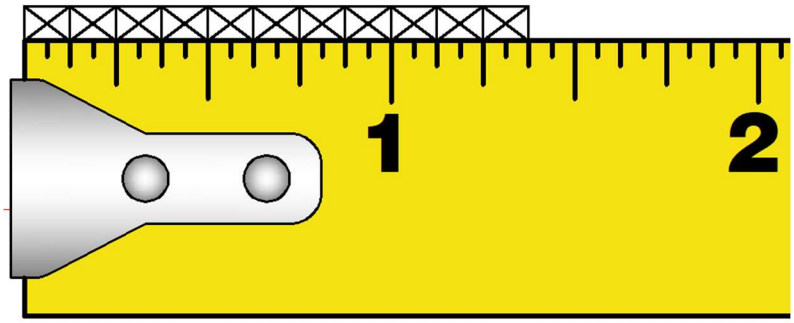


Figure 48 3/4 can be converted to 6/8 by doubling the top and bottom

So, when adding or subtracting ruler fractions, our first job is to make sure the denominators are the same. With ruler fractions, we can usually do that by doubling the top and bottom numbers. We may also need to exchange a whole inch for smaller fractions, or combine smaller fractions into a whole inch. Once you understand those few ideas, adding and subtracting measurements becomes much easier.

Now let's look at multiplying and dividing ruler fractions. We'll start with two very useful operations: doubling and halving.

There's a trick that makes halving and doubling fractions quick and easy. To double a fraction, double the top number (the numerator). To halve a fraction, double the bottom number (the denominator).

Suppose we have a measurement of three-eighths of an inch, and we want to double it. We can simply double the top number. Three times two is six, so three-eighths times two is six-eighths. And since six-eighths can be reduced to three-quarters, that's our answer.

$$\frac{2}{1} \times \frac{3}{8} = \frac{6}{8}$$

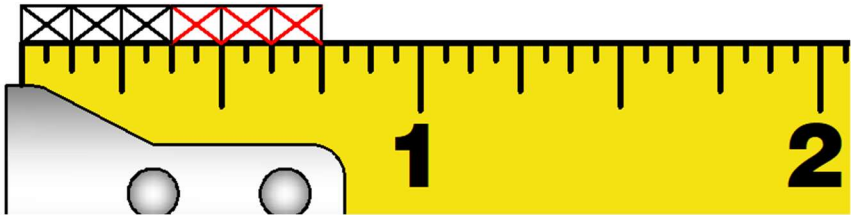


Figure 49 Learn the trick to doubling and halving fractions

Now, suppose we want to cut that same three-eighths measurement in half. This time, instead of doubling the top number, we can double the bottom number. Three-eighths becomes three-sixteenths. Remember, when we double the number of equal pieces in an inch, each piece becomes half as large. So three-sixteenths is half of three-eighths.

$$\frac{1}{2} \times \frac{3}{8} = \frac{3}{16}$$

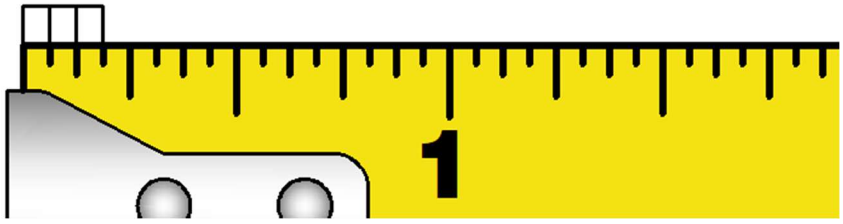


Figure 50 Find half by doubling the denominator

That's a useful shortcut with ruler fractions. To double a fraction, double the top number. To halve a fraction, double the bottom number. Of course, we should simplify the answer when we can.

Let's work an example. Say a panel that is 15 and five eighths inches wide needs to be mounted at its center. We need to find half of its width to find the center. Half of 15 is 7 ½, to find half of ⅝, we double the eight to sixteen, so we'll have 5/16. We'll take 7 and a half and add 5/16 to find the center. We could work this out with the measuring tape, mark the 7 and a half and then count off 5 sixteenths to find the center, or we could add 8 sixteenths (one half) and 5 sixteenths to get 13 sixteenths. Half of 15 ⅝ is 7 and thirteen sixteenths.

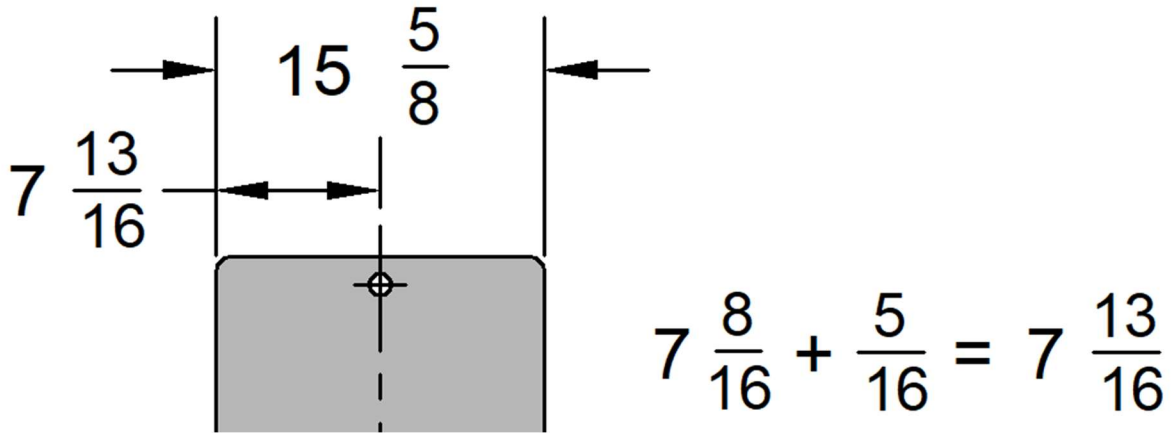


Figure 51 Finding the center by halving

Now let's try multiplying a mixed number. Suppose we're making four identical spacers, each one and one-quarter inches long. What is their combined length?

We can multiply the whole inches and the fractional inches separately. Four times one inch is four inches. Four times one-quarter inch is four-quarters, which makes another whole inch. Add them together, and we get five inches.

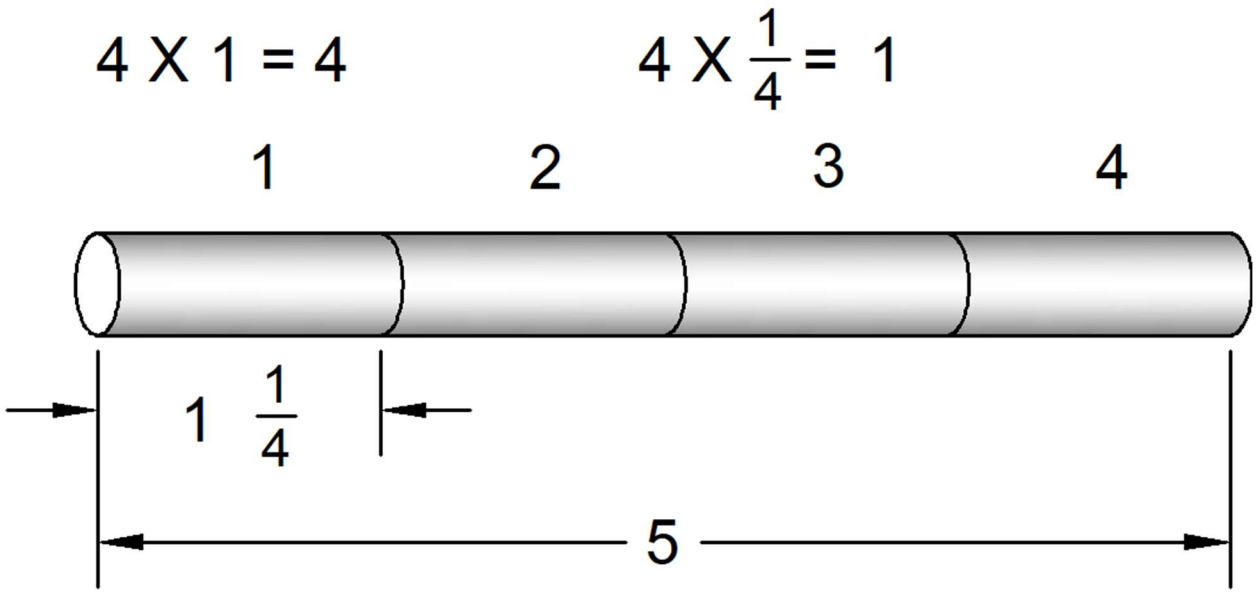


Figure 52 Multiplication of fractions can be easier than adding

With ruler fractions, these operations are often easier than they first appear. Whether we're adjusting a measurement, making several identical parts, or dividing a length into equal pieces, understanding how these fractions work helps us get the correct measurement.

Eventually, you'll run into more complicated fraction problems than the ones we talked about, but these simple rules are the ones that come up most often. Working with fractions can take some getting used to. But with practice it will get easier and easier.

Unit 6 – Review Questions

Math with Ruler Fractions

Name: _____ Date: _____

Choose the best answer or enter the requested value. Show your work when helpful.

Part A — Multiple Choice

1. To add 1/4 inch and 3/8 inch, which fraction is equivalent to 1/4 inch?

A. 1/8
B. 2/8
C. 3/8
D. 4/8

2. What is 1/4 + 3/8 inch?

A. 4/12 in.
B. 1/2 in.
C. 5/8 in.
D. 7/8 in.

3. A mark at 12 1/4 inches must move 3/8 inch farther from zero. What is the new mark?

A. 12 3/8 in.
B. 12 1/2 in.
C. 12 5/8 in.
D. 12 7/8 in.

4. What is 1/4 + 1/16 inch?

A. 2/16 in.
B. 3/16 in.
C. 5/16 in.
D. 1/4 in.

5. What is 3 1/8 − 1/2 inch?

A. 2 3/8 in.
B. 2 5/8 in.
C. 2 7/8 in.
D. 3 3/8 in.

6. What is 5/8 + 3/4 inch?

A. 7/8 in.
B. 1 1/8 in.
C. 1 3/8 in.
D. 1 5/8 in.

7. What is twice 3/8 inch?

A. 3/16 in.
B. 3/4 in.
C. 5/8 in.
D. 6/16 in.

8. What is half of 3/8 inch?

A. 3/16 in.
B. 3/4 in.
C. 1/8 in.
D. 1/4 in.

9. Four spacers are each 1 1/4 inches long. What is their combined length?

A. 4 1/4 in.
B. 4 1/2 in.
C. 5 in.
D. 5 1/4 in.

10. What is half of a 15 5/8-inch panel width?

A. 7 5/16 in.
B. 7 13/16 in.
C. 7 5/8 in.
D. 8 5/16 in.

Part B — Numerical Answers

11. Add 1/8 + 3/8 inch. Enter the answer as a decimal number of inches.

Answer: _____

12. Add 1/2 + 1/4 inch. Enter the answer as a decimal number of inches.

Answer: _____

13. Subtract 7/8 − 1/4 inch. Enter the answer as a decimal number of inches.

Answer: _____

14. A bar is 6 1/2 inches long. Add 1/4 inch. Enter the new length as a decimal number of inches.

Answer: _____

15. A piece is 4 1/4 inches long. Remove 3/4 inch. Enter the result as a fraction.

Answer: _____

16. Double 5/16 inch. Enter the result as a fraction.

Answer: _____

17. Find half of 1 1/4 inches. Enter the result as a fraction.

Answer: _____

18. Three identical pieces are each 2 1/4 inches long. Enter their combined length as a decimal number of inches.

Answer: _____

Part C — Matching

19. Match each expression with its value.

1. 1/8 + 1/8 _____
2. 1/8 + 3/8 _____
3. 1/4 + 1/2 _____
4. 5/8 + 3/8 _____

A. ¾
B. ¼
C. 1
D. 1/2

20. Match each operation with the method used.

1. Add 1/4 + 1/8 _____
2. Subtract 3 1/8 − 1/2 _____

3. Double 3/16 _____
4. Halve 3/8 _____

A. Double the numerator (top)
B. Convert 1/4 to 2/8
C. Double the denominator (bottom)
D. Exchange one whole inch for eighths

Unit 6 – Instructor Answer Key

Math with Ruler Fractions

Part A — Multiple Choice

1. B — 2/8. 1/4 = 2/8, so the denominators match.
2. C — 5/8 in.. 2/8 + 3/8 = 5/8 inch.
3. C — 12 5/8 in.. 12 1/4 + 3/8 = 12 2/8 + 3/8 = 12 5/8.
4. C — 5/16 in.. 1/4 = 4/16; add 1/16 to get 5/16.
5. B — 2 5/8 in.. Borrow one inch: 3 1/8 = 2 9/8; subtract 4/8 to get 2 5/8.
6. C — 1 3/8 in.. 5/8 + 6/8 = 11/8 = 1 3/8.
7. B — 3/4 in.. Doubling 3/8 gives 6/8 = 3/4.
8. A — 3/16 in.. Halving 3/8 gives 3/16.
9. C — 5 in.. 4 × 1 1/4 = 4 + 4/4 = 5 inches.
10. B — 7 13/16 in.. 15 5/8 ÷ 2 = 7 13/16 inches.

Part B — Numerical Answers

11. 0.5. 4/8 = 1/2 = 0.5 inch.
12. 0.75. 2/4 + 1/4 = 3/4 = 0.75 inch.
13. 0.625. 7/8 − 2/8 = 5/8 = 0.625 inch.
14. 6.75. 6 1/2 + 1/4 = 6 3/4 = 6.75 inches.
15. 3.5. 4 1/4 − 3/4 = 3 1/2 = 3.5 inches.
16. 0.625. 10/16 = 5/8 = 0.625 inch.
17. 0.625. 1 1/4 = 5/4; half is 5/8 = 0.625 inch.
18. 6.75. 3 × 2 1/4 = 6 3/4 = 6.75 inches.

Part C — Matching

19. 1–B; 2–D; 3–A; 4–C.
1. 1/8 + 1/8 = ¼
2. 1/8 + 3/8 = ½
3. 1/4 + 1/2 = ¾
4. 5/8 + 3/8 = 1
20. 1–B; 2–D; 3–A; 4–C.

1. Add 1/4 + 1/8 = Convert 1/4 to 2/8
2. Subtract 3 1/8 − 1/2 = Exchange one whole inch for eighths
3. Double 3/16 = Double the numerator
4. Halve 3/8 = Double the denominator