RATIO AND RATE

Introduction

Both **ratios** and **rates** are used to compare quantities. A **ratio** is used to compare two quantities with the same unit, and a **rate** is used to compare two quantities with different units. We will look at both of these concepts in this lesson.

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RATIO AND RATE

A **ratio** is the quotient of two quantities.

A ratio can be expressed in three different ways:

- as a fraction written in lowest terms,
- as a statement with the word "to" written between the two numbers, or
- with a colon between the two numbers.

EXAMPLE A

There are 20 female students and 25 male students in a prealgebra course. What is the ratio of female students to male students in the course? Write it in three different ways.

i) $\frac{\text{female students}}{\text{male students}} = \frac{20}{25} = \frac{4}{5}$ Since we are comparing students with students this comparison is a ratio. Write the ratio as a fraction in lowest terms.

ii) Ratio of female students to male students: 4 to 5 Write the ratio as a statement.

iii) Ratio of female students to male students: 4 : 5 Write the ratio with a colon.

EXAMPLE B

To make the syrup for her jam recipe, Marta uses one cup of water for every two cups of sugar. Show this as a ratio, written in three different ways.

i) $\frac{\text{water}}{\text{sugar}} = \frac{1}{2}$ Since we are comparing cups with cups, this comparison is a ratio. Write the ratio as a fraction in lowest terms.

ii) Ratio of water to sugar: 1 to 2 Write the ratio as a statement.

iii) Ratio of water to sugar: 1 : 2 Write the ratio with a colon.

RATIO AND RATE

A rate is the quotient of two quantities that have different units.

A rate is expressed in the form of a simplified fraction.

EXAMPLE C

Write the rate that represents driving 93 miles in six hours.

$\frac{93 \text{ miles}}{6 \text{ hours}}$ Since we are comparing miles with hours (different units), this comparison is a rate.

$\frac{93 \text{ miles}}{6 \text{ hours}} = \frac{31 \text{ miles}}{2 \text{ hours}}$ Write the rate as a fraction. The fraction should be simplified to lowest terms.

EXAMPLE D

Write the rate that represents this situation: Ann received 55 dollars for 10 hours of work.

$\frac{55 \text{ dollars}}{10 \text{ hours}}$ Since we are comparing dollars with hours, this comparison is a rate.

$\frac{55 \text{ dollars}}{10 \text{ hours}} = \frac{11 \text{ dollars}}{2 \text{ hours}}$ Write the rate as a fraction. The fraction should be simplified to lowest terms.

When the denominator of a rate is 1, then it is a **unit rate**. In Example D above, we can find out how much Ann was paid for one hour of work—see Example E.

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RATIO AND RATE

EXAMPLE E

Write the unit rate that represents this situation: Ann received 55 dollars for 10 hours of work.

To find the unit rate, first write the rate as a fraction and then divide the numerator by the denominator.

$\frac{55 \text{ dollars}}{10 \text{ hours}}$ Write the rate as a fraction.

$55 \div 10 = 5.5$ or $\frac{5.5 \text{ dollars}}{1 \text{ hour}}$ Divide 55 by 10 to find the unit rate.

Ann made $5.50 per hour.

EXAMPLE F

Joe paid $12.50 for a 5-pound bag of apples. Find the cost of one pound of apples.

$\frac{12.5 \text{ dollars}}{5 \text{ pounds}}$ Write the rate as a fraction.

$12.5 \div 5 = 2.5$ or $\frac{2.5 \text{ dollars}}{1 \text{ pound}}$ Divide 12.5 by 5 to find the unit rate.

The cost for one pound of apples is $2.50.

Extended Example 1a

To make a glaze for her cinnamon rolls, Julia uses two tablespoons of water for every six tablespoons of powdered sugar. Show this as a ratio, written in three different ways.

Use the information below to write the ratio as a simplified fraction.

The ratio of the number of pages she read to the number of pages left.

Write the ratio as a) a simplified fraction, b) a statement, and c) using a colon.

In a deck of cards, the number of hearts to the whole deck.

Write the simplified rate that represents the situation.

Shelia paid $50 for 6 DVDs.

Give the unit rate for the situation.

Marcus biked 150 miles in 15 hours. How many miles did he travel per hour?

Give the unit rate for the situation.

A carton of 12 eggs cost $2.64. What is the cost of 1 egg?

PROPORTION

Introduction

Two ratios set equal to each other creates a **proportion**:

$$\frac{a}{b} = \frac{c}{d}.$$

We will study proportions in this lesson.

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PROPORTION

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

In the proportion above, a and d are called the **extremes** of the proportion and b and c are called the **means** of the proportion. A proportion is true if the **property of proportions** holds. If the property does not hold then the proportion is false.

Property of Proportions

$$\frac{a}{b}=\frac{c}{d} \quad \Leftrightarrow \quad ad=bc$$

This property states that **the product of the extremes is equal to the product of the means**. That is, if you multiply the elements of a proportion diagonally (or **cross-multiply**), the two products are equal. Observe:

$$\frac{3}{4}=\frac{12}{16}$$

$$\frac{3}{4}\times\!\!\searrow\!\!\nearrow\frac{12}{16} \quad \rightarrow \quad 3\times 16=4\times 12$$

$$48=48 \quad \textbf{True}$$

EXAMPLE A

Is $\frac{2}{3}=\frac{6}{10}$ a true proportion?

$2\cdot 10=20$ Multiply the extremes: $2\cdot 10=20$.

$3\cdot 6=18$ Multiply the means: $3\cdot 6=18$.

but $20\neq 18$ **False** Set the two products equal to each other; true?

No, this proportion is false.

PROPORTION

If one of the four elements a, b, c, or d is unknown, then the proportion becomes an equation that can be solved for the unknown. To solve a proportion with an unknown, use the **property of proportions** to create a new equation.

EXAMPLE B

Solve: $\frac{3}{7} = \frac{x}{21}$

$7 \cdot x = 3 \cdot 21$ To solve for x, first use the property of proportions and cross-multiply.

$7x = 63$ Multiply the extremes: $3 \cdot 21 = 63$. Multiply the means: $7 \cdot x = 7x$. Set the two products equal to each other.

$x = \frac{63}{7}$ Solve the equation for x: divide both sides by 7 and simplify.

$x = 9$

EXAMPLE C

Solve: $\frac{2m}{9} = \frac{1}{5}$

$2m \cdot 5 = 1 \cdot 9$ To solve for m, use the property of proportions.

$10m = 9$ Multiply the extremes: $2m \cdot 5 = 10m$. Multiply the means: $1 \cdot 9 = 9$. Set the two products equal to each other.

$m = \frac{9}{10}$ Solve the equation for m: divide both sides by 10.

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PROPORTION

EXAMPLE D

Solve: $\frac{4}{15} = \frac{2}{x}$

$4 \cdot x = 2 \cdot 15$ To solve for x, use the property of proportions and cross-multiply.

$4x = 30$ Multiply the extremes: $4 \cdot x = 4x$. Multiply the means: $2 \cdot 15 = 30$. Set the two products equal to each other.

$x = \frac{30}{4}$ Now solve the equation for x: divide both sides by 4.

$x = \frac{15}{2}$ Simplify.

PROPORTION

Is $\frac{5}{43} = \frac{25}{215}$ a true proportion?

Extended Example 1a

END OF LESSON

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Determine if the proportion is true or false.

$$\frac{5}{16}=\frac{10}{48}$$

Determine if the proportion is true or false.

$$\frac{60}{78.8}=\frac{12}{19.7}$$

Solve the proportion for the unknown.

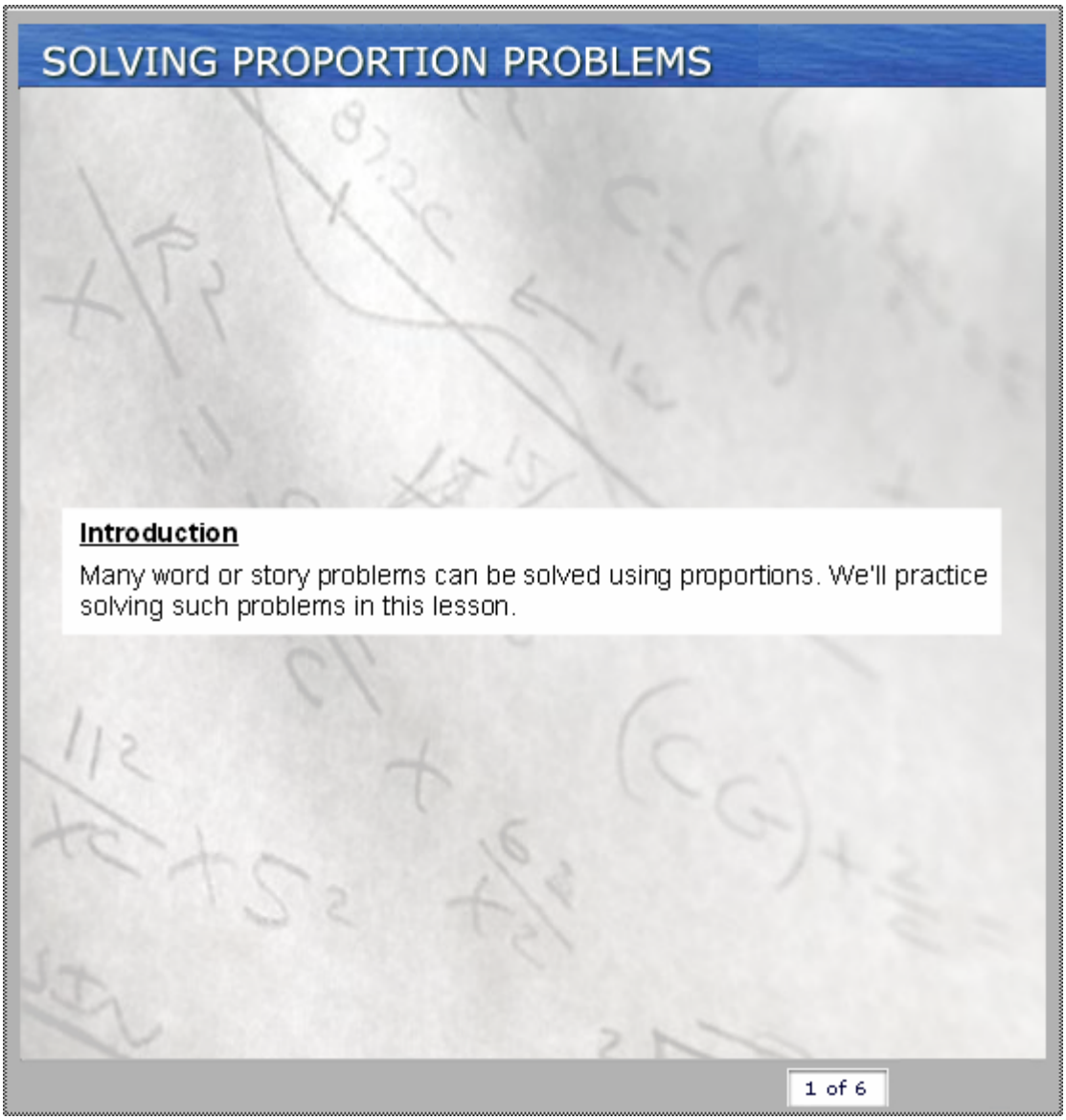
$$\frac{-7}{k}=\frac{-21}{39}$$

Solve the proportion for the unknown.

$$\frac{-5}{4x} = \frac{5}{7}$$

Solve the proportion for the unknown.

$$\frac{11.6}{-168} = \frac{-2.9}{7v}$$


SOLVING PROPORTION PROBLEMS
Introduction
Many word or story problems can be solved using proportions. We'll practice solving such problems in this lesson.
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SOLVING PROPORTION PROBLEMS

EXAMPLE A

If 6 cases of bottled juice cost $45 and Bob needs only 4 cases, how much will Bob pay for 4 cases?

Let x represent the unknown quantity. One ratio is 6 cases to $45: $\frac{6 \text{ cases}}{\$45}$.

The other ratio is 4 cases to $\$x$: $\frac{4 \text{ cases}}{\$x}$. Set the two ratios equal to each other to create the proportion to solve:

$$\frac{6 \text{ cases}}{\$\,45} = \frac{4 \text{ cases}}{\$\,x}.$$

To solve the proportion, drop the units and solve for x using the property of proportions (cross-multiply).

$$\frac{6}{45} = \frac{4}{x}$$
$$6x = 4(45)$$
$$6x = 180$$
$$x = \frac{180}{6}$$
$$x = 30$$

Bob will pay $30 for 4 cases of bottled juice.

SOLVING PROPORTION PROBLEMS

EXAMPLE B

A cookie recipe uses 5 cups of sugar to make 24 cookies. How many cups of sugar should be used if you only want to make 12 cookies?

Let x represent the unknown quantity. One ratio is 5 cups of sugar to 24 cookies: $\frac{5 \text{ cups of sugar}}{24 \text{ cookies}}$. The other ratio is x cups of sugar to 12 cookies: $\frac{x \text{ cups of sugar}}{12 \text{ cookies}}$. Set the two ratios equal to each other to create the proportion:

$$\frac{5 \text{ cups of sugar}}{24 \text{ cookies}} = \frac{x \text{ cups of sugar}}{12 \text{ cookies}}.$$

To solve the proportion, drop the units and solve for x using the property of proportions.

$$\frac{5}{24} = \frac{x}{12}$$
$$24 \cdot x = 5(12)$$
$$24x = 60$$
$$x = \frac{60}{24}$$
$$x = \frac{5}{2}$$
$$x = 2.5$$

You will need 2.5 cups of sugar.

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SOLVING PROPORTION PROBLEMS

EXAMPLE C

The recipe for a cake calls for $2\frac{2}{3}$ cups of sugar for every $3\frac{1}{2}$ cups of flour. If Ann uses 4 cups of sugar, how many cups of flour does she need?

Let x represent the unknown quantity. One ratio is $2\frac{2}{3}$ cups of sugar to $3\frac{1}{2}$ cups of flour: $\frac{2\frac{2}{3} \text{ cups of sugar}}{3\frac{1}{2} \text{ cups of flour}}$. The other ratio is 4 cups of sugar to x cups of flour: $\frac{4 \text{ cups of sugar}}{x \text{ cups of flour}}$. Set the two ratios equal to each other to create the proportion:

$$\frac{2\frac{2}{3} \text{ cups of sugar}}{3\frac{1}{2} \text{ cups of flour}} = \frac{4 \text{ cups of sugar}}{x \text{ cups of flour}}.$$

To solve the proportion, drop the units and solve for x using the property of proportions.

$$\frac{2\frac{2}{3}}{3\frac{1}{2}} = \frac{4}{x} \quad \Rightarrow \quad \frac{\frac{8}{3}}{\frac{7}{2}} = \frac{4}{x}$$

$$\frac{8}{3} \cdot x = \frac{7}{2} \cdot 4$$

continued...

SOLVING PROPORTION PROBLEMS

Example C, continued...

$$\frac{8}{3}\cdot x = \frac{7}{2}\cdot 4$$

$$\frac{8}{3}x = \frac{7}{\cancel{2}^{1}}\cdot\frac{\cancel{4}^{2}}{1}$$

$$\frac{8}{3}x = \frac{14}{1}$$

$$\frac{3}{8}\cdot\frac{8}{3}x = \frac{3}{8}\cdot\frac{14}{1}$$

$$\frac{\cancel{3}}{\cancel{8}}\cdot\frac{\cancel{8}}{\cancel{3}}x = \frac{3}{\cancel{8}^{4}}\cdot\frac{\cancel{14}^{7}}{1}$$

$$x = \frac{21}{4} \quad \Rightarrow \quad x = 5\frac{1}{4}$$

Ann needs $5\frac{1}{4}$ cups of flour.

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SOLVING PROPORTION PROBLEMS

Extended Example 1a

If 3 pounds of apples cost $5.64, what is the cost of 2 pounds of apples?

END OF LESSON

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The recipe for a pasta dish that makes 5 servings requires 3 cups of dried pasta. How much pasta is needed for 2 servings?

The cost of 3 cases of bottled water is $17.91. How many cases will cost $11.94?

A cookie recipe calls for 3 cups of sugar for every 1 cup of chocolate.

How much sugar is needed for $3\frac{1}{2}$ cups of chocolate?

On a blueprint, $\frac{1}{4}$ inch represents $1\frac{1}{2}$ feet.

How many feet does a $5\frac{1}{4}$ inch line represent?

On a blueprint, $\frac{1}{4}$ inch represents $1\frac{1}{2}$ feet.

How many inches represent 11 feet?

ENGLISH SYSTEM OF MEASUREMENT

Introduction

In everyday life, we use measurement for many different purposes. For example, we measure items in a recipe; we measure the area of the floor of a room for carpet; and we measure distance when following driving directions. In the United States, the **English System** is used to measure distance, weight, and capacity.

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ENGLISH SYSTEM OF MEASUREMENT

English Measurements

Length	Weight
12 inches (in) = 1 foot (ft) 3 ft = 1 yard (yd) 1,760 yd = 1 mile (mi) = 5,280 ft	16 ounces (oz) = 1 pound (lb) 2,000 lb = 1 Ton (T)

Capacity (Liquid Volume)

8 fluid ounces (fl oz) = 1 cup (c)
2 c = 1 pint (pt)
2 pt = 1 quart (qt)
4 qt = 1 gallon (gal)

There may be times when a given measurement is not in the units needed for a specific purpose. In these situations it is necessary to convert from one unit to another. Notice in the table above that there is not a consistent relationship between each unit of measurement. For example, in length measurement, from one unit to the other, the conversion changes from 12 to 3 to 1,760. This fact can make conversions between English units slightly complicated.

ENGLISH SYSTEM OF MEASUREMENT

Converting Between English Units

Unit fractions can be used to convert from one unit to another. A **unit fraction** is a rate of units that is equal to 1. Some unit fractions of common English measurements follow:

a. $\frac{3\text{ ft}}{1\text{ yd}} = \frac{1\text{ yd}}{3\text{ ft}} = 1$ **b.** $\frac{16\text{ oz}}{1\text{ lb}} = \frac{1\text{ lb}}{16\text{ oz}} = 1$ **c.** $\frac{4\text{ qt}}{1\text{ gal}} = \frac{1\text{ gal}}{4\text{ qt}} = 1$

Unit fractions in **a** above would be used to convert between feet and yards, **b** would be used to convert between ounces and pounds, and **c** would be used to convert between quarts and gallons. Note how **a**, **b**, and **c** above relate to this table. According to the table, what would be the unit fractions that relate pints to quarts? They would be $\frac{2\text{ pt}}{1\text{ qt}}$ and $\frac{1\text{ qt}}{2\text{ pt}}$.

When choosing the appropriate unit fraction to use in your conversion, select the unit fraction whose numerator contains the units that you are converting to. For example, if converting feet into yards, choose the unit fraction with yard in the numerator: $\frac{1\text{ yd}}{3\text{ ft}}$. However, if converting yards into feet, choose $\frac{3\text{ ft}}{1\text{ yd}}$, since feet is in the numerator.

Once the appropriate unit fraction is chosen, then it is multiplied by the measure you intend to convert. Study the examples that follow.

ENGLISH SYSTEM OF MEASUREMENT

EXAMPLE A

Convert 30 inches to feet. Refer to this table.

$30 \text{ in} \cdot \frac{1 \text{ ft}}{12 \text{ in}}$ The unit fractions for inches and feet are $\frac{12 \text{ in}}{1 \text{ ft}}$ and $\frac{1 \text{ ft}}{12 \text{ in}}$.

The conversion is to feet, so use $\frac{1 \text{ ft}}{12 \text{ in}}$, since feet is in the numerator.

$\frac{30^{5} \cancel{\text{in}}}{1} \cdot \frac{1 \text{ ft}}{{}_{2}\cancel{12 \text{ in}}} = \frac{5}{1} \cdot \frac{1 \text{ ft}}{2}$ Multiply the fractions, canceling like units.

Simplify.

$= \frac{5 \text{ ft}}{2} = \frac{5}{2} \text{ft}$

$= 2.5 \text{ ft}$ So: $30 \text{ in} = 2.5 \text{ ft}$.

EXAMPLE B

Convert 13 pounds to ounces. Refer to this table.

$13 \text{ lb} \cdot \frac{16 \text{ oz}}{1 \text{ lb}}$ The unit fractions for pounds and ounces are $\frac{1 \text{ lb}}{16 \text{ oz}}$ and $\frac{16 \text{ oz}}{1 \text{ lb}}$. The conversion is to ounces so use $\frac{16 \text{ oz}}{1 \text{ lb}}$, since ounce is in the numerator.

$\frac{13 \cancel{\text{lb}}}{1} \cdot \frac{16 \text{ oz}}{1 \cancel{\text{lb}}} = \frac{13}{1} \cdot \frac{16 \text{ oz}}{1}$ Multiply the fractions, canceling like units.

Simplify.

$= 208 \text{ oz}$ So: $13 \text{ lb} = 208 \text{ oz}$.

ENGLISH SYSTEM OF MEASUREMENT

The method of converting with unit fractions shown in Examples A and B can be used for converting between any two units of the same type (length, weight, or capacity). Sometimes in order to convert from one unit to another, several unit fractions are needed.

EXAMPLE C

Convert 126 inches to yards. Refer to this table.

$$\frac{126\text{ in}}{1}\cdot\frac{1\text{ ft}}{12\text{ in}}\cdot\frac{1\text{ yd}}{3\text{ ft}}$$ Use unit fractions to change inches to feet and then feet to yards.

$$\frac{126\ \cancel{\text{in}}}{1}\cdot\frac{1\ \cancel{\text{ft}}}{12\ \cancel{\text{in}}}\cdot\frac{1\text{ yd}}{3\ \cancel{\text{ft}}}=\frac{126}{(12)(3)}\text{ yd}$$ Multiply the fractions, canceling like units. Simplify.

$$=\frac{126}{36}\text{ yd}=\frac{7}{2}\text{ yd}$$

$$=3.5\text{ yd}$$ So: $126\text{ in}=3.5\text{ yd}$.

EXAMPLE D

Convert 2.5 gallons to fluid ounces. Refer to this table.

$$\frac{2.5\text{ gal}}{1}\cdot\frac{4\text{ qt}}{1\text{ gal}}\cdot\frac{2\text{ pt}}{1\text{ qt}}\cdot\frac{2\text{ c}}{1\text{ pt}}\cdot\frac{8\text{ fl oz}}{1\text{ c}}$$ Use unit fractions to change gallons to quarts, quarts to pints, pints to cups, and finally cups to fluid ounces.

$$\frac{2.5\ \cancel{\text{gal}}}{1}\cdot\frac{4\ \cancel{\text{qt}}}{1\ \cancel{\text{gal}}}\cdot\frac{2\ \cancel{\text{pt}}}{1\ \cancel{\text{qt}}}\cdot\frac{2\ \cancel{\text{c}}}{1\ \cancel{\text{pt}}}\cdot\frac{8\text{ fl oz}}{1\ \cancel{\text{c}}}$$ Multiply the fractions, canceling like units. Simplify.

$$=2.5(4)(2)(2)(8)\text{ fl oz}$$

$$=320\text{ fl oz}$$ So: $2.5\text{ gal}=320\text{ fl oz}$.

ENGLISH SYSTEM OF MEASUREMENT

Extended Example 1a

Convert 9 cups to pints. Refer to this table.

END OF LESSON

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Convert the measurement.

500 lb = _____ T

Convert the measurement.

120 yd = _____ft

Convert the measurement.

10 c = _____ qt

Convert the measurement.

128 fl oz= _____ qt

Convert the measurement.

500 c = _____ gal

METRIC SYSTEM OF MEASUREMENT

Introduction

The **Metric System** of measurement is used in most countries around the world. In the United States, the metric system is used for scientific measurements. The Metric system differs from the English system in that the Metric system has an equal and organized relationship between the units.

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METRIC SYSTEM OF MEASUREMENT

Metric Measurements

Metric units are all in base 10.

Length	Mass
1 millimeter (mm) = $\frac{1}{1{,}000}$ m	1 milligram (mg) = $\frac{1}{1{,}000}$ g
1 centimeter (cm) = $\frac{1}{100}$ m = 10 mm	1 centigram (cg) = $\frac{1}{100}$ g = 10 mg
1 decimeter (dm) = $\frac{1}{10}$ m = 10 cm	1 decigram (dg) = $\frac{1}{10}$ g = 10 cg
1 meter (m) = 10 dm	1 gram (g) = 10 dg
1 dekameter (dam) = 10 m	1 dekagram (dag) = 10 g
1 hectometer (hm) = 100 m = 10 dam	1 hectogram (hg) = 100 g = 10 dag
1 kilometer (km) = 1,000 m = 10 hm	1 kilogram (kg) = 1,000 g = 10 hg

Capacity (Liquid Volume)

1 **milli**liter (mL) = $\frac{1}{1{,}000}$ L

1 **centi**liter (cL) = $\frac{1}{100}$ L = 10 mL

1 **deci**liter (dL) = $\frac{1}{10}$ L = 10 cL

1 liter (L) = 10 dL

1 **deka**liter (daL) = 10 L

1 **hecto**liter (hL) = 100 L = 10 daL

1 **kilo**liter (kL) = 1,000 L = 10 hL

Notice that, in all three categories, the change from one unit to the next is always 10 units. For example, in length measurement, each unit is ten times larger than the previous unit. The base unit of length is the **meter**, of weight is the **gram**, and of volume is the **liter.**

METRIC SYSTEM OF MEASUREMENT

Converting Between Metric Units

As with English units, unit fractions can be used to convert from one Metric unit to another.

Recall, a **unit fraction** is a rate of units that is equal to 1. Some unit fractions of Metric measurements follow.

a. $\frac{100\text{ cm}}{1\text{ m}} = \frac{1\text{ m}}{100\text{ cm}} = 1$ **b.** $\frac{100\text{ g}}{1\text{ hg}} = \frac{1\text{ hg}}{100\text{ g}} = 1$ **c.** $\frac{100\text{ mL}}{1\text{ dL}} = \frac{1\text{ dL}}{100\text{ mL}} = 1$

Unit fraction **a** would be used to convert between centimeters and meters, **b** would be used to convert between grams and hectograms, and **c** would be used to convert between milliliters and deciliters.

As is the case with English units, when choosing the appropriate unit fraction to use in your conversion, select the unit fraction whose numerator contains the units that you are converting to.

Study the examples that follow.

METRIC SYSTEM OF MEASUREMENT

EXAMPLE A

Convert 65 centigrams to grams. Refer to this table.

$65\text{ cg} \cdot \frac{1\text{ g}}{100\text{ cg}}$ The unit fractions for centigrams and grams are $\frac{1\text{ g}}{100\text{ cg}}$ and $\frac{100\text{ cg}}{1\text{ g}}$. The conversion is to grams, so use $\frac{1\text{ g}}{100\text{ cg}}$, since gram is in the numerator.

$\frac{65^{13}\,\text{cg}}{1} \cdot \frac{1\text{ g}}{100^{20}\,\text{cg}} = \frac{13}{1} \cdot \frac{1\text{ g}}{20}$ Multiply the fractions, canceling like units. Simplify.

$= \frac{13\text{ g}}{20}$

$= \frac{13}{20}\text{ g}$

$= 0.65\text{ g}$ So: $65\text{ cg} = 0.65\text{ g}$.

EXAMPLE B

Convert 5.25 kilometers to meters. Refer to this table.

$5.25\text{ km} \cdot \frac{1{,}000\text{ m}}{1\text{ km}}$ The unit fractions for meters and kilometers are $\frac{1\text{ km}}{1{,}000\text{ m}}$ and $\frac{1{,}000\text{ m}}{1\text{ km}}$. The conversion is to meters, so use $\frac{1{,}000\text{ m}}{1\text{ km}}$, since meter is in the numerator.

$\frac{5.25\,\text{km}}{1} \cdot \frac{1{,}000\text{ m}}{\text{km}} = 5.25(1{,}000)\text{ m}$ Multiply the fractions, canceling like units. Simplify.

$= 5{,}250\text{ m}$ So: $5.25\text{ km} = 5{,}250\text{ m}$.

METRIC SYSTEM OF MEASUREMENT

The method of converting with unit fractions we've seen can be used for converting between any two units. Sometimes in order to convert from one Metric unit to another, several unit fractions are needed.

EXAMPLE C

Convert 9 kiloliters to centiliters. Refer to this table.

$9\text{ kL} \cdot \frac{1{,}000\text{ L}}{1\text{ kL}} \cdot \frac{100\text{ cL}}{1\text{ L}}$ Use unit fractions $\frac{1{,}000\text{ L}}{1\text{ kL}}$ and $\frac{100\text{ cL}}{1\text{ L}}$.

$$\frac{9\ \cancel{\text{kL}}}{1} \cdot \frac{1{,}000\ \cancel{\text{L}}}{1\ \cancel{\text{kL}}} \cdot \frac{100\text{ cL}}{1\ \cancel{\text{L}}} = 9(1{,}000)(100)\text{ cL}$$

Multiply the fractions. Simplify.

$$= 900{,}000\text{ cL}$$

So: $9\text{ kL} = 900{,}000\text{ cL}$.

EXAMPLE D

Convert 539 milligrams to dekagrams. Refer to this table.

$539\text{ mg} \cdot \frac{1\text{ g}}{1{,}000\text{ mg}} \cdot \frac{1\text{ dag}}{10\text{ g}}$ Use unit fractions $\frac{1\text{ g}}{1{,}000\text{ mg}}$ and $\frac{1\text{ dag}}{10\text{ g}}$.

$$\frac{539\ \cancel{\text{mg}}}{1} \cdot \frac{1\ \cancel{\text{g}}}{1{,}000\ \cancel{\text{mg}}} \cdot \frac{1\text{ dag}}{10\ \cancel{\text{g}}} = \frac{539}{(1{,}000)(10)}\text{ dag}$$

Multiply the fractions. Simplify.

$$= \frac{539}{10{,}000}\text{ dag}$$

$$= 0.0539\text{ dag}$$

So: $539\text{ mg} = 0.0539\text{ dag}$.

METRIC SYSTEM OF MEASUREMENT

Extended Example 1a

Convert 9,428 milliliters to liters. Refer to this table.

END OF LESSON

Convert the measurement.

179 dL = _____ L

Convert the measurement.

15.04 L = _____ hL

Convert the measurement.

59.4 dam = _____ cm

Convert the measurement.

95 cL = _____ kL

Convert the measurement.

0.34 daL = _____ mL

CONVERTING BETWEEN SYSTEMS OF MEASUREMENTS AND TEMPERATURE

Introduction

We have learned about the English and Metric systems of measurement and how to convert between units within each system. Now, we'll learn how to convert between the two systems of measurement. We'll also look at the temperature scale used in each of these systems of measurement, and how to convert between them.

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CONVERTING BETWEEN SYSTEMS OF MEASUREMENTS AND TEMPERATURE

Converting Between Systems of Measurement

It is often necessary to convert between English and metric units. The following table can be used to approximate conversions.

English to Metric	Metric to English
Length	**Length**
1 in ≈ 2.54 cm 1 ft ≈ 0.30 m 1 yd ≈ 0.91 m 1 mi ≈ 1.61 km	1 cm ≈ 0.39 in 1 m ≈ 3.28 ft 1 m ≈ 1.09 yd 1 km ≈ 0.62 mi
Weight/Mass	**Weight/Mass**
1 oz ≈ 28.35 g 1lb ≈ 0.45 kg	1 g ≈ 0.035 oz 1 kg ≈ 2.20 lb
Capacity (Liquid Volume)	**Capacity (Liquid Volume)**
1 qt ≈ 0.95 L 1 gal ≈ 3.78 L	1 L ≈ 1.06 qt 1 L ≈ 0.26 gal

Note: ≈ mean "approximately"

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CONVERTING BETWEEN SYSTEMS OF MEASUREMENTS AND TEMPERATURE

Unit fractions can also be used to convert between the English and Metric units.

Recall, a unit fraction is a rate of units that is equal to 1. Some unit fractions for conversion between systems of measurement are shown below.

a. $\frac{2.54\text{ cm}}{1\text{ in}} = \frac{0.39\text{ in}}{1\text{ cm}} \approx 1$ **b.** $\frac{0.45\text{ kg}}{1\text{ lb}} = \frac{2.20\text{ lb}}{1\text{ kg}} \approx 1$ **c.** $\frac{0.95\text{ L}}{1\text{ qt}} = \frac{1.06\text{ qt}}{1\text{ L}} \approx 1$

Unit fraction **a** would be used to convert between centimeters and inches, **b** would be used to convert between kilograms and pounds, and **c** would be used to convert between liters and quarts.

As when converting within systems of measurement, when choosing the appropriate unit fraction to use in your conversion between systems, select the unit fraction whose numerator contains the units that you are converting to.

Study the examples that follow.

CONVERTING BETWEEN SYSTEMS OF MEASUREMENTS AND TEMPERATURE

EXAMPLE A

Convert 35 centimeters to inches. Refer to this table.

$35\text{ cm} \cdot \frac{0.39\text{ in}}{1\text{ cm}}$ The unit fractions for centimeters and inches are $\frac{2.54\text{ cm}}{1\text{ in}}$ and $\frac{0.39\text{ in}}{1\text{ cm}}$. The conversion is to inches, so use $\frac{0.39\text{ in}}{1\text{ cm}}$, since inches is in the numerator.

$\frac{35\text{ cm}}{1} \cdot \frac{0.39\text{ in}}{1\text{ cm}} = \frac{35}{1} \cdot \frac{0.39\text{ in}}{1}$ Multiply the fractions. Simplify.

$= 35(0.39)\text{ in}$

$= 13.65\text{ in}$ So: $35\text{ cm} = 13.65\text{ in}$.

EXAMPLE B

Convert 10 quarts to liters. Refer to this table.

$10\text{ qt} \cdot \frac{0.95\text{ L}}{1\text{ qt}}$ The unit fractions for quarts and liters are $\frac{0.95\text{ L}}{1\text{ qt}}$ and $\frac{1.06\text{ qt}}{1\text{ L}}$. The conversion is to liters, so use $\frac{0.95\text{ L}}{1\text{ qt}}$ since liters is in the numerator.

$\frac{10\text{ qt}}{1} \cdot \frac{0.95\text{ L}}{1\text{ qt}} = \frac{10}{1} \cdot \frac{0.95\text{ L}}{1}$ Multiply the fractions, canceling like units. Simplify.

$= 10(0.95)\text{ L}$

$= 9.5\text{ L}$ So: $10\text{ qt} = 9.5\text{ L}$.

CONVERTING BETWEEN SYSTEMS OF MEASUREMENTS AND TEMPERATURE

Extended Example 1a

Convert 100 meters to feet.

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CONVERTING BETWEEN SYSTEMS OF MEASUREMENTS AND TEMPERATURE

Temperature

As with length, weight, and capacity, there are also two different systems for measuring temperature. In the Metric system, temperature is measured in degrees **Celsius** (°C). In the English system, temperature is measured in degrees **Fahrenheit** (°F).

Temperature Scales	
English System: Fahrenheit	**Metric System: Celsius**
Water boils at 212 degrees Fahrenheit (212°F).	Water boils at 100 degrees Celsius (100°C).
Body temperature is 98.6 degrees Fahrenheit (98.6°F).	Body temperature is 37 degrees Celsius (37°C).
Water freezes at 32 degrees Fahrenheit (32°F).	Water freezes at 0 degrees Celsius (0°C).

To convert between Celsius and Fahrenheit use one of the following equations:

To convert from **Celsius to Fahrenheit**:	To convert from **Fahrenheit to Celsius**:
$F = \frac{9}{5}C + 32$	$C = \frac{5(F-32)}{9}$

Note: When using these equations be sure to follow the order of operations!

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CONVERTING BETWEEN SYSTEMS OF MEASUREMENTS AND TEMPERATURE

EXAMPLE C

Convert 20°C to Fahrenheit.

$F = \frac{9}{5}C + 32$ The conversion is from Celsius to Fahrenheit so use the equation: $F = \frac{9}{5}C + 32$.

$= \frac{9}{5}(20) + 32$ Replace C with 20.

$= \frac{9}{\cancel{5}^{1}} \cdot \frac{\cancel{20}^{4}}{1} + 32$ Follow the order of operations. Simplify.

$= 9(4) + 32$

$= 36 + 32 = 68$ So: $20°C = 68°F$.

EXAMPLE D

Convert 90°F to Celsius.

$C = \frac{5(F - 32)}{9}$ The conversion is from Fahrenheit to Celsius so use the equation: $C = \frac{5(F - 32)}{9}$.

$= \frac{5(90 - 32)}{9}$ Replace F with 90.

$= \frac{5(58)}{9}$ Follow the order of operations. Simplify.

$= \frac{290}{9}$

$= 32.2222... = 32.\overline{2}$ So: $90°F \approx 32.2°C$.

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CONVERTING BETWEEN SYSTEMS OF MEASUREMENTS AND TEMPERATURE

Extended Example 2a

Convert –6 °C to Fahrenheit.

END OF LESSON

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Convert the measurement.

65 in = _____ m

Convert the measurement.

0.378 kL = _____ gal

Convert the measurement.

9,000 mg = _____ lb

Convert the measurement.

30°C = _____ °F

Convert the measurement.

104°F = _____ °C