

# Mathematics: Additional Topics

Measurement  
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# Learning Outcomes

- Convert one unit of measure to another using unit ratios
- Convert one unit of measure to another using conversion factors
- Add and subtract customary measures
- Multiply and divide customary measures
- Change one US customary rate of measure to another



# Convert Using Ratios

- Four basic units used to measure length
  - 12 inches = 1 foot
  - 3 feet = 1 yard
  - 36 inches = 1 yard
  - 5,280 feet = 1 mile



- Mass: the quantity of material that makes up the object
- Weight: the earth's gravitational pull on the object



### 3 Commonly used measures for weight/mass

- Ounce, Pound, Ton
  - 16 ounces = 1 pound
  - 2,000 pounds = 1 ton



- Capacity or Volume: More common to measure dry capacity by weight than in terms of capacity
- Common units of measure for capacity or volume:

- ounce

3 teaspoons = 1 table spoon

- cup

8 ounces = 1 cup

- pint

2 cups = 1 pint

- quart

2 pints = 1 quart

- gallon

2 table spoons = 1 ounce

4 cups = 1 quart

4 quarts = 1 gallon



- Ratio: a fraction
- Unit Ratio: is a fraction with one unit of measure in the numerator (top) and a different, but equivalent unit of measure in the denominator (bottom)

$$\frac{12 \text{ inches}}{1 \text{ foot}}$$

$$\frac{1 \text{ foot}}{12 \text{ inches}}$$

$$\frac{3 \text{ feet}}{1 \text{ yard}}$$

$$\frac{1 \text{ mile}}{5,280 \text{ feet}}$$



# To change from one unit to another

1. Write the original measure in the numerator of a fraction with 1 as the denominator
2. Multiply this fraction by a unit ratio with the original unit (from 1) in the denominator with the new unit in the numerator
3. Reduce like units of measure and all numbers where possible



# Examples

- The number of inches in 5 feet

$$\frac{5 \cancel{\text{feet}}}{1} = \frac{12 \text{ inches}}{1 \cancel{\text{foot}}} = 60 \text{ inches}$$

Remember: any number  
divided by itself = 1

- How many pints are in 4.5 quarts

$$\frac{4.5 \cancel{\text{quart}}}{1} = \frac{2 \text{ pt}}{1 \cancel{\text{quart}}} = 9 \text{ pt}$$



# Dimension Analysis

- The systematic examination of the appropriate measuring limits of a solution
- To change from yards to inches:
  - yards → feet → inches
- To change from gallons to ounces:
  - gallons → quarts → pints → cups → ounces



# Convert using Conversion Factors

1. Write a unit ratio that changes the given unit to the new unit
2. Change the fraction (or ratio) to its decimal equivalent by dividing the numerator by the denominator

Example: Pounds to ounces:

$$\frac{\text{pounds}}{1} \cdot \frac{\text{ounces}}{\text{pounds}}$$

$$\frac{1 \text{ pound}}{1} \cdot \frac{16 \text{ ounces}}{1 \text{ pounds}} = \frac{16 \text{ ounces}}{1}$$

Ounces to pounds:

$$\frac{\text{ounces}}{1} \cdot \frac{\text{pounds}}{\text{ounces}}$$

$$\frac{1 \text{ ounce}}{1} \cdot \frac{1 \text{ pound}}{16 \text{ ounces}} = \frac{1}{16} = 0.0625 \text{ pounds}$$



- Mixed measures: measures that use 2 or more units
- Standard notation: The number associated with each unit of measure is smaller than the number required to convert to the next larger unit.



# Express mixed measures in Standard Notation

1. Start with the smallest unit of measure and determine if there are enough units to make one or more of the next larger unit
2. Regroup to make as many of the larger units as possible
3. Combine like units
4. Repeat the process with each given measuring unit



# Standard Notation

## Examples

• 8 LB 20 OZ

• 8 lb + 1 lb + 4 oz = 9 lb 4 oz

(20 oz = 1 lb 4 oz)

• 1 GAL 5 QT

• 1 gal + 1 gal + 1 qt = 2 gal 1 qt

(5 qt = 1 gal 1 qt)

• 2 YD 4 FT 16 IN

• 2 yd + 4 ft + 1 ft + 4 in

(16 in = 1 ft 4 in)

• 2 yd + 5 ft + 4 in

• 2 yd + 1 yd + 2 ft + 4 in = 3 yd 2 ft 4 in

(5 ft = 1 yd 2 ft)



# Adding and Subtracting

- Can add only when units are the same
1. Convert each measure to a measure with a common unit
  2. Add the unit of measure - reduce to standard notation if needed

- 3 feet + 2 inches  
( $3 \times 12 = 36$  inches)

$$36 \text{ in} + 2 \text{ in} = 38 \text{ in}$$

- 6 lb 7 oz

+ 3 lb 13 oz

---

9 lb 20 oz

9 lb 1 lb 4 oz

10 lb 4 oz (Standard Notation)



Change 60 miles per hour to feet per second

$$\left( \frac{\cancel{60} \text{ miles}}{\cancel{1} \text{ hour}} \right) \left( \frac{5280 \text{ ft}}{\cancel{1} \text{ mile}} \right) \left( \frac{\cancel{1} \text{ hr}}{60 \text{ min}} \right) \left( \frac{\cancel{1} \text{ min}}{\cancel{60} \text{ sec}} \right)$$

$$\left( \frac{5280 \text{ ft}}{60 \text{ sec}} \right) = \left( 88 \frac{\text{ft}}{\text{sec}} \right)$$