

Introduction to measurement and the U.S. Customary Units and Dimensional Analysis

1. Write down as many U.S. units of length that you know.
2. Write down as many U.S. units of weight that you know
3. Write down as many U.S. units of capacity (capacity is the same as liquid measure) that you know.
4. Write down as many U.S. units of time that you know.
5. Below are tables containing conversion equations for U.S. Units of length, capacity, time and weight.

U.S. Units of Length
$12 \text{ in} = 1 \text{ ft}$
$3 \text{ ft} = 1 \text{ yd}$
$5280 \text{ ft} = 1 \text{ mi}$

U.S. Units of Capacity
$16 \text{ fl oz} = 1 \text{ pt}$
$2 \text{ pt} = 1 \text{ qt}$
$4 \text{ qt} = 1 \text{ gal}$

U.S. Units of Time
$60 \text{ sec} = 1 \text{ min}$
$60 \text{ min} = 1 \text{ hr}$
$24 \text{ hr} = 1 \text{ day}$
$7 \text{ days} = 1 \text{ wk}$
$52 \text{ wk} = 1 \text{ yr}$
$12 \text{ mo} = 1 \text{ yr}$
$365 \text{ days} = 1 \text{ yr}$

U.S. Units of Weight
$16 \text{ oz} = 1 \text{ lb}$
$2000 \text{ lb} = 1 \text{ ton}$

6. How many feet are there in 32 in?
7. How many oz in 5.5 lb?
8. When you convert from one unit to another, which 2 operations do you have to choose from?

Sometimes, it's hard to know which operation to choose when converting from one unit to another. An easy way to make these conversions is to use a process called Dimensional Analysis. To understand Dimensional Analysis, we need to understand 2 basic ideas. Complete #s 9 – 15 and you will know what those ideas are.

9. Simplify:

$$5 \times 1 = \underline{\quad\quad} \quad 23 \times 1 = \underline{\quad\quad} \quad -7 \times 1 = \underline{\quad\quad}$$

$$1\frac{3}{4} \text{ qt} \times 1 = \underline{\quad\quad} \quad 7 \text{ days} \times 1 = \underline{\quad\quad} \quad 16 \text{ oz} \times 1 = \underline{\quad\quad}$$

10. What conclusion can you make from the problems in # 9?
11. Write an algebraic equation for your conclusion.

12. Simplify:

$$\frac{2}{2} = \underline{\quad\quad} \quad \frac{3}{3} = \underline{\quad\quad} \quad \frac{-8}{-8} = \underline{\quad\quad} \quad \frac{163}{163} = \underline{\quad\quad}$$

$$\frac{12 \text{ in}}{1 \text{ ft}} = \underline{\quad\quad} \quad \frac{1 \text{ ft}}{12 \text{ in}} = \underline{\quad\quad} \quad \frac{1 \text{ pt}}{16 \text{ fl oz}} = \underline{\quad\quad} \quad \frac{60 \text{ min}}{1 \text{ hr}} = \underline{\quad\quad}$$

13. What conclusion can you make from the problems in # 12?
14. Write an algebraic equation for your conclusion.

15. Fill in the blanks to make a true statement. Use the relationships from the tables above.

$$\frac{\boxed{} \text{ ft}}{1 \text{ mi}} = 1$$

$$\frac{1 \text{ mi}}{\boxed{} \text{ ft}} = 1$$

$$\frac{\boxed{} \text{ pt}}{1 \text{ qt}} = 1$$

$$\frac{1 \text{ qt}}{\boxed{} \text{ pt}} = 1$$

$$\frac{52 \text{ wk}}{\boxed{} \text{ yr}} = 1$$

$$\frac{\boxed{} \text{ min}}{1 \text{ hr}} = 1$$

$$\frac{1 \text{ lb}}{\boxed{} \text{ oz}} = 1$$

$$\frac{\boxed{} \text{ oz}}{1 \text{ lb}} = 1$$

Note: We can use these 2 ideas, $a \times 1 = a$ and $1 = \frac{\text{a number}}{\text{itself}} = \frac{\text{a quantity}}{\text{an equivalent quantity}}$

to convert from one unit to another. This process is called Dimensional Analysis. Study the examples below to understand how Dimensional Analysis works.

Example 1: How many fluid ounces (fl oz) in 5 pints (pt) ?

$$5 \text{ pt} = 5 \text{ pt} \times 1$$

[Multiplying by 1 doesn't change the value of 5 pt.]

$$= \frac{5 \text{ pt}}{1} \times \frac{16 \text{ fl oz}}{1 \text{ pt}}$$

[Since 16 fl oz = 1 pt, we replace 1 with the unit

$$\text{fraction: } 1 = \frac{16 \text{ fl oz}}{1 \text{ pt}}]$$

$$= \frac{5 \cancel{\text{ pt}}}{1} \times \frac{16 \text{ fl oz}}{1 \cancel{\text{ pt}}}$$

[Cancel pt which is the unit you don't want. You're then left with fl oz which is the unit you're changing to.]

$$= \frac{5 \times 16 \text{ fl oz}}{1}$$

[Multiply the fractions.]

$$= 80 \text{ fl oz}$$

[Finish multiplying]

16. In Example 1, why did we replace 1 with $\frac{16 \text{ fl oz}}{1 \text{ pt}}$ instead of replacing 1 with $\frac{1 \text{ pt}}{16 \text{ fl oz}}$?

Example 2: How many miles is 7,920 ft?

- Which conversion equation should you use for this problem?
- What unit fraction will you use? _____ Why?
- Using the pattern in Example 1, fill in the blanks:

$$7,920 \text{ ft} = 7,920 \text{ ft} \times 1$$

$$= \frac{7,920 \text{ ft}}{1} \times \frac{\boxed{}}{\boxed{}}$$

$$= \frac{7,920 \text{ ft}}{1} \times \frac{\boxed{}}{\boxed{}}$$

$$= \frac{\boxed{}}{\boxed{}}$$

$$= \boxed{} \quad \text{[Remember that units are part of the answer.]}$$

Notes: In order to change units using Dimensional Analysis:

- Choose a conversion equation that relates the units you want to change to the units you want to get.
- Using this conversion equation, write the unit fraction in such a way so that the units you want to change will cancel.
- Multiply the quantity that you want to change by the unit fraction from Step 2. Cancel the units and do the arithmetic that remains.

Ex. a. 45 min = _____ hr

b. 3 ½ tons = _____ lb

$$\frac{45 \cancel{\text{min}}}{1} \times \frac{1 \text{ hr}}{60 \cancel{\text{min}}} = \frac{45}{60} \text{ hr} = \frac{3}{4} \text{ hr}$$

$$\frac{3 \frac{1}{2} \cancel{\text{tons}}}{1} \times \frac{2000 \text{ lb}}{1 \cancel{\text{ton}}} = \frac{3 \frac{1}{2} \times 2000}{1} \text{ lb} = 7000 \text{ lb}$$

17. Change each quantity to the indicated unit.

a. 48 oz = _____ lb

b. 8400 lb = _____ ton

c. 168 hr = _____ days

d. 4 days = _____ hr

e. 8 qt = _____ pt

f. 2 yr = _____ wk

Example 3: How many minutes in 3 weeks? How is this conversion different from the ones in Examples 1 & 2?

Note: To change from weeks to minutes, we need to multiply by more than one unit fraction.

$$\frac{3 \cancel{wk}}{1} \times \frac{7 \cancel{days}}{1 \cancel{wk}} \times \frac{24 \cancel{hrs}}{1 \cancel{day}} \times \frac{60 \text{ min}}{1 \cancel{hr}} = 30,240 \text{ min}$$

18. Change each quantity to the indicated unit.

a. 8 qt = _____ fl oz

b. 10,080 hr = _____ wk

c. 7200 sec = _____ hr

d. $\frac{1}{4}$ day = _____ sec

19. Samantha said that she had $1\frac{3}{4}$ qt of iced tea and Bennie said that he had 56 fl oz of iced tea. Who has more? Try to do this problem in two different ways.

20. Change each quantity to the indicated unit.

a. $2\frac{1}{4}$ qt = _____ gal

b. 6500 lb = _____ tons

c. 3 gal = _____ fl oz

d. 3 wk = _____ hr

21. A recipe calls for $\frac{1}{2}$ qt of milk. If you have $1\frac{1}{2}$ pt on hand, is this enough?