DETAILED SOLUTIONS AND CONCEPTS - SYSTEMS OF MEASUREMENT
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YOU MUST BE ABLE TO DO THE FOLLOWING PROBLEMS WITHOUT A CALCULATOR!

The U.S. customary system of measurement evolved from the British system of measurements. In our discussion we will only include selected measuring units.

Common U.S. Customary Units of Linear Measure

1 inch (in) *

1 foot (ft) = 12 inches (in) **

1 yard (yd) = 3 feet (ft)

1 mile (mi) = 1,760 yards (yd)

> * inches are often abbreviated with a quotation mark **"**. For Problem, **12 in** can be written as **12"**.

> ** feet are often abbreviated with an apostrophe **'**. For Problem, **12 ft** can be written as **12'**.

Common U. S. Customary Units of Weight

1 ounce (oz)

1 pound (lb *******) = 16 ounces (oz)

1 ton (T) = 2,000 pounds (lb)

> ******* The abbreviation lb for pound is derived from a Latin weight called libra!

Common U.S. Customary Units of Liquid Capacity

1 ounce (oz)   **Please note that ounce is both a unit of weight and liquid capacity!**

1 pint (pt) = 16 ounces (oz)

1 quart (qt) = 2 pints (pt)
      1 quart (qt) = 32 ounces (oz)

1 gallon (gal) = 4 quarts (qt)
      1 gallon (gal) = 128 ounces (oz)

Common Metric Units of Linear Measure

NOTE: The metric system is an international system of measurement that is based on powers of 10. To express a certain metric unit as a larger or smaller metric unit all that is required is to move the decimal point a proper number of places to the left or right.

1 millimeter (mm)

1 centimeter (cm) =10 millimeters (mm)

1 decimeter (dm) = 10 centimeters (cm)

1 meter (m) = 10 decimeters (dm)

1 kilometer (km) = 10 hectometers (hm)

Common Metric Units of Weight

1 milligram (mg)

1 centigram (cg) =10 milligrams (mg)

1 gram (g) = 10 decigrams (dg)

1 kilogram (kg) = 10 hectograms (hg)

Common Metric Units of Liquid Capacity

1 milliliter (mL)   1 milliliter = 1 cubic centimeter (cc)

1 centiliter (cL) = 10 milliliters (mL)

1 liter (L) = 10 deciliter (dL) = 100 cL = 1,000 mL

Converting from One Unit of Measure to Another

The easiest way to change from one unit of measure to another is to use the **Unit Ratio Method**. The unit ratio contains the given unit of measure and the unit of measure to which we are to convert. **Use the conversion charts above to help you write appropriate ratios!**

Rule:

- Set up the original amount as a fraction with its unit of measure in the numerator.
- Find a unit ratio containing the new unit of measure and the original unit of measure in such a manner that you can cross-cancel the original unit of measure.
- Multiply the original number associated with the unit of measure in fraction form with the unit ratio.

Expressing Mixed Measures in Standard Notation

Vocabulary:

Mixed measures contain two or more units of measure. For Problem, 2 feet 2 inches.

A mixed measure is in **standard notation** if the number associated with each unit of measure is smaller than the number required to convert to the next larger unit of measure.

For Problem, 3 feet 2 inches is NOT in standard notation because 3 feet = 1 yard, therefore, 3 feet 2 inches = 1 yard 2 inches.

Furthermore, in standard notation **the numbers associated with the units of measure are whole numbers** unless it is the number associated with the smallest unit of measure.

For Problem, $5 yd \frac{1}{4} ft$ is NOT in standard notation because $\frac{1}{4} ft$ can be written as **3 in**.

Therefore, we would express $5 yd \frac{1}{4} ft$ as **5 yd 3 in**.

Rule:

- Start with the smallest unit of measure and decide if the number associated with it is equal to or bigger than the number required to convert it to the next larger unit of measure.
- Then make as many larger units of measure as possible.
- Add the numbers associated with these larger units of measure to any already existing like units of measures.
- Repeat the process above with these units of measure.

Time

Time is measured in hours, minutes, and seconds.

1 minute = 60 seconds

1 hour = 60 minutes = 3,600 seconds

Time can be expressed using a 12-hour clock using AM for mornings and PM for afternoons. For example 6 Am and 6 PM

However, time can also be expressed using a 24-hour clock. Sometimes this is called military time because it is used by the military. In this case, we add 12 to the AM time to get the PM time. For example, we would use 6:00 for the morning and 18:00 for the evening. This is expressed as "6 hundred hours" and "18 hundred hours."

Problem 1:

Change *76.53 feet* to *inches*.

First, we'll write the original measure as the fraction $\dfrac{76.53\ ft}{1}$

Looking at the conversion charts above, we find a unit ratio in which the new unit of measure (inches) is in the numerator and the original unit of measure (feet) is in the denominator:

$$\dfrac{12\ in}{1\ ft}$$

Now, we'll multiply the original measure in fraction form with the unit ratio:

$$\dfrac{76.53\ ft}{1}\left(\dfrac{12\ in}{1\ ft}\right) = \dfrac{76.53(12)\ in}{1}$$

$$= 918.36\ in$$

Notice that we cross-canceled the original units of measure so that only the new unit of measure remains.

Problem 2:

How many **pints** are in **5.6 quarts** ?

First, we'll write the original measure as the fraction $\dfrac{5.6\,qt}{1}$

Looking at the conversion charts above, we find a unit ratio in which the new unit of measure (pints) is in the numerator and the original unit of measure (quarts) is in the denominator:

$$\dfrac{2\,pt}{1\,qt}$$

Now, we'll multiply the original measure in fraction form with the unit ratio:

$$\dfrac{5.6\,qt}{1}\left(\dfrac{2\,pt}{1\,qt}\right)=\dfrac{5.6(2)\,pt}{1}$$

$$=11.2\,pt$$

Problem 3:

How many **inches** are in $1\dfrac{3}{4}$ **mile** ?

First, we'll write the original measure as the improper fraction $\dfrac{7\,mi}{4}$

Looking at the conversion charts above, we find NO unit ratio that relates the original measure (miles) to the new measure (inches).

Method 1:

You can make up your own unit ratio remembering that there are 5280 feet in one mile.

Then

$$\dfrac{7\,mi}{4}\left(\dfrac{5280\,ft}{1\,mi}\right)\left(\dfrac{12\,in}{1\,ft}\right)=\dfrac{7(5280)(12)\,in}{4}$$

$$=\dfrac{443520\,in}{4}$$

$$=110880\,in$$

Method 2:

From the conversion charts above we know that one mile contains 1760 yards, one yard contains 3 feet, and one foot contains 12 inches. We will use the following three unit ratios to change to the new unit of measure.

$$\frac{1760\ yd}{1\ mi}\ \text{and}\ \frac{3\ ft}{1\ yd}\ \text{and}\ \frac{12\ in}{1\ ft}$$

Now, we'll multiply the original measure in fraction form with both unit ratios:

$$\frac{7\ mi}{4}\left(\frac{1760\ yd}{1\ mi}\right)\left(\frac{3\ ft}{1\ yd}\right)\left(\frac{12\ in}{1\ ft}\right) = \frac{7(1760)(3)(12)\ in}{4}$$
$$= \frac{443520\ in}{4}$$
$$= 110880\ in$$

Problem 4:

Express *4 ft 18 in* in standard notation.

Starting with the smallest unit of measure (inches), we find that

18 in = 12 in + 6 in can be changed to *1 ft 6 in*.

Therefore, *4 ft 18 in = 4 ft + 1 ft 6 in*

                         = 5 ft 6 in and since *1 yd = 3 ft*, we can write

                         = 1 yd 2 ft 6 in

Problem 5:

Express *90 inches* in standard notation.

We find that *90 in = 7(12) in + 6 in* and since *1 ft = 12 in*, we can write

                 90 in = 7 ft 6 in and since *1 yd = 3 ft*, we can write

                     = 2 yd 1 ft 6 in

Problem 6:

Express **7 lb 19 oz** in standard notation.

Starting with the smallest unit of measure (ounces), we find that

19 oz = 16 oz + 3 oz = can be changed to **1 lb 3 oz**

> Note that there is usually no "and" or "+" in between different units of measure!

Therefore, **7 lb 19 oz = 7 lb + 1 lb 3 oz**

= 8 lb 3 oz

Problem 7:

Express **2 gal 6 qt** in standard notation.

Starting with the smallest unit of measure (quarts), we find that

6 qt = 4 qt + 2 qt can be changed to **1 gal 2 qt**.

Therefore, **2 gal 6 qt = 2 gal + 1 gal 2 qt**

= 3 gal 2 qt

Problem 8:

Express **3 yd 5 ft 13 in** in standard notation.

Starting with the smallest unit of measure (inches), we find that

13 in = 12 in + 1 in can be changed to **1 ft 1 in**.

Therefore, **3 yd 5 ft 13 in = 3 yd 5 ft + 1 ft 1 in**

= 3 yd 6 ft 1 in

Continuing to the next unit of measure (feet), we find that

6 ft = 3 ft + 3 ft can be changed to **2 yd**.

Therefore, **3 yd 6 ft 1 in = 3 yd + 2 yd 1 in**

= 5 yd 1 in

Problem 9:

Change **0.378 m** to **mm**.

First, we'll write the original measure as the fraction $\dfrac{0.378\,m}{1}$.

Looking at our conversion charts above, we find a unit ratio in which the new unit of measure (mm) is in the numerator and the original unit of measure (m) is in the denominator:

$$\frac{1000\,mm}{1\,m}$$

Now, we'll multiply the original measure in fraction form with the unit ratio:

$$\frac{0.378\,\cancel{m}}{1}\left(\frac{1000\,mm}{1\,\cancel{m}}\right) = \frac{0.378(1000)\,mm}{1(1)}$$
$$= 378\,mm$$

Notice that we cross-canceled the original units of measure so that only the new unit of measure remains.

Problem 10:

How many **km** are in **789 m** ?

First, we'll write the original measure as the fraction $\dfrac{789\,m}{1}$.

Looking at our conversion charts above, we find a unit ratio in which the new unit of measure (km) is in the numerator and the original unit of measure (m) is in the denominator:

$$\frac{1\,km}{1000\,m}$$

Now, we'll multiply the original measure in fraction form with the unit ratio:

$$\frac{789\,\cancel{m}}{1}\left(\frac{1\,km}{1000\,\cancel{m}}\right) = \frac{789\,km}{1(1000)}$$
$$= 0.789\,km$$

Problem 11:

How many **mL** are in **0.714 L** ?

First, we'll write the original measure as the improper fraction $\dfrac{0.714\,L}{1}$.

Looking at our conversion charts above, we find a unit ratio in which the new unit of measure (mL) is in the numerator and the original unit of measure (L) is in the denominator:

$$\dfrac{1000\,mL}{1L}$$

Now, we'll multiply the original measure in fraction form with the unit ratio:

$$\dfrac{0.714\,\cancel{L}}{1}\left(\dfrac{1000\,mL}{1\,\cancel{L}}\right) = \dfrac{0.714(1000)\,mL}{1(1)}$$

$$= 714\,mL$$

Problem 12:

Express **659 g** as **kg**.

First, we'll write the original measure as the fraction $\dfrac{659\,g}{1}$.

Looking at our conversion charts above, we find a unit ratio in which the new unit of measure (kg) is in the numerator and the original unit of measure (g) is in the denominator:

$$\dfrac{1\,kg}{1000\,g}$$

Now, we'll multiply the original measure in fraction form with the unit ratio:

$$\dfrac{659\,\cancel{g}}{1}\left(\dfrac{1\,kg}{1000\,\cancel{g}}\right) = \dfrac{659\,kg}{1(1000)}$$

$$= 0.659\,kg$$

Problem 13:

Convert 4 hours to minutes and to seconds.

1 hour = 60 minutes

then *1(4) hours = 60(4) minutes*

Finally, 4 hours = 240 minutes.

1 hour = 3600 seconds

then *1(4) hours = 3600(4) seconds*

Finally, 4 hours = 14,400 seconds.

Problem 14:

An factory worker can assemble a bicycle in 25 minutes. How long will it take him to assemble 7 bicycles? Express the time in standard notation using hours and minutes!

7(25) = 175 minutes

Knowing that *1 hour = 60 minutes*, then *175 minutes = 2(60) minutes + 55 minutes = 2 hours 55 minutes*.

It takes the factory worker 2 hours 55 minutes to assemble 7 bicycles.

Problem 15:

Assume you leave on your vacation to Yellowstone Park at 4:30 AM and arrive in Salt Lake City, Utah at 11:39 AM. You decide to eat lunch and leave Salt Lake City at 1:05 PM. You arrive at your destination at 8:35 PM. What was your traveling time? Express it in standard notation using hours and minutes!

NOTE: **Mixed measures** contain two or more units of measure. For example, 2 hours and 27 minutes.   A mixed measure is in **standard notation** if the number associated with each unit of measure is smaller than the number required to convert to the next larger unit of measure.

For example, 1 hour and 85 minutes is not in standard notation because 85 minutes can be written as 1 hour and 25 minutes. Therefore, we would express 1 hour 85 minutes as 2 hours 25 minutes.

The traveling time between your home and Salt Lake City can be calculated as follows:

11:39 - 4:30 = 7 hours 9 minutes.

Since we are working with two AM times, we simply subtract the hours from the hours and the minutes from the minutes!

The time you spent for lunch can be calculated as follows:

1:05 - 11:39

Here we are working with an AM and a PM time. Since the hour of the PM time is smaller than the hour of the AM time, we must use a 24-hour clock and change 1:05 PM to 13:05! Remember, we add 12!

That is, we have to calculate **13:05 - 11:39**.

However, we still have a problem because the minutes of the PM time are smaller than those of the AM time. We can fix this by "borrowing" minutes from the PM hour as follows:

12:65 - 11:39 = 1 hour 26 minutes

The time you spent driving to your destination from Salt Lake City after lunch can be calculated as follows:

8:35 - 1:05 = 7 hours 30 minutes

Notice that we did not have to convert to a 24-hour clock since we are working with PM times

Our traveling time is **7 hours 9 minutes + 1 hour 26 minutes + 7 hours 30 minutes = 15 hours 65 minutes**.

Knowing that **1 hour = 60 minutes**, then **65 minutes = 1(60) minutes + 5 minutes = 1 hour 5 minutes**

and **15 hours + 1 hour 5 minutes = 16 hours 5 minutes**.

It takes 16 hours 5 minutes to travel to Yellowstone Park.