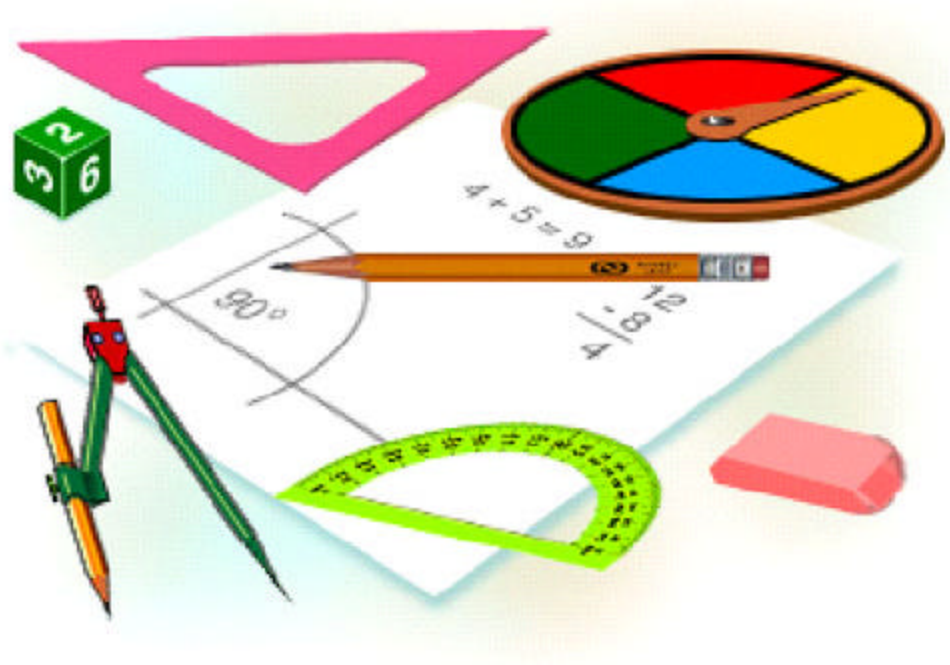
The Next Step

Mathematics Applications for Adults



Teacher's Manual:

Customary Measurement

SECTION 4

Customary Measurement

"Never measure the height of a mountain until you have reached the top. Then you will see how low it was."
-*Dag Hammarskjold*

OUTLINE

Mathematics – Teacher's Manual

Section 4
Customary Measurement System
Customary Measurement Answer Key

Customary Measurement System

A measurement system that measures length in inches, feet, yards, and miles; capacity in cups, pints, quarts, and gallons; weight in ounces, pounds, and tons; and temperature in degrees Fahrenheit

Since the customary English system of measurement is still common in the United States, students should learn both customary and metric systems and should know some rough equivalences between the metric and customary systems

Measuring Length and Distance

The Romans were the first to use the ***foot*** as a measure. The foot was equal to the length of a grown man's foot. Originally, the foot was divided into twelve uncia, or ***inches***.

The Romans also created the ***mile***. The mile was the distance covered by 1.000 paces of a Roman soldier, or about 5,280 feet. The Roman measurement---feet, inches, and miles---were picked up by the tribes of Britain. Over time, the measures were changed and some new measurements were created.

During the 1100s, the length of the British king's arm became known as the ***yard***. The yard was about three Roman feet long.

Around the same time, the British wanted to make measurement more exact. Using body parts was no longer accurate enough, because two bodies are never exactly the same. So the British created a standard length from an iron bar. They called the bar the standard yard.

Table of Length and Distance Units - Customary:
12 inches (in.) = 1 foot (ft.)
36 inches (in.) = 1 yard (yd.)
3 feet = 1 yard
5,280 feet = 1 mile (mi.)
1,760 yards = 1 mile

Measuring Weight

More than 3,000 years ago, the Egyptians invented a scale made of a stick hung from a piece of rope. From the ends of the stick were hung two more ropes. Objects to be weighed were tied to one of the ropes hanging from the end of the stick. Standard weights were tied to the other end. Standard weights included full bags of grain, stones, or seeds.

Until quite recently, almost all weights were stated in avoirdupois units in all English-speaking countries. The name of the system comes from the French phrase *avoir du poids*, "goods of weight," indicating simply that the goods were being sold by weight rather than by volume or by the piece. The avoirdupois system was introduced in England around 1300, replacing an older commercial system. Scholars believe the avoirdupois pound was invented by

wool merchants and modeled on a ***pound*** of 16 ***ounces*** used in Florence, Italy, which was an important buyer of English wool at the time. The avoirdupois weights quickly became the standard weights of trade and commerce. They continue to be used for most items of retail trade in the United States, and they remain in some use in Britain despite the introduction of metric units there.

Ounces, pounds, and ***tons*** are customary units used to measure everything except precious metals and gemstones, and medicine.

A different scale called troy weight is used to measure precious metals and gemstones. You're probably familiar with the "carat" unit for measuring something like gold, for instance.

Medicines are measured on a scale that is similar to troy weight called Apothecaries' measures, but this scale includes some liquid measures as well as solid weights. You may have heard your pharmacist speak of "drams" or "drops" when discussing certain types of medicine.

Table of Weight Units - Customary:
16 ounces (oz) = 1 pound (lb)
2000 pounds (lb) = 1 ton (T)

The abbreviation ***lb.*** comes from the Latin "libra", meaning a pound balance. When the English adopted the pound measure, they kept the Latin abbreviation.

In the United States, there are exactly 2000 pounds in the ton. In Britain, there are 2240 pounds in the ton. To distinguish between the two units, the British ton is called the **long ton** and the American one is the **short ton**. In old England, a "tun" was a large cask used to store wine. Because these tuns were of standard size, more or less, the tun came to represent both a volume unit, indicating the capacity of a cask, and also a weight unit, indicating the weight of a cask when it was full.

Measuring Volume

Liquids and gases can only be measured by volume. Customary units include ***fluid ounces***, ***cups***, ***pints***, ***quarts***, and ***gallons***.

A fluid ounce is a traditional unit of liquid volume named as such to avoid confusion with the weight ounce. A fluid ounce of water weighs just a bit more than one ounce.

A cup is a traditional unit of volume used in recipes in the United States. American cooks use the same size cup for measuring both liquid and dry substances.

A quart is another traditional unit of volume, so-called because it equals exactly 1/4 (one quarter) of a gallon, and a pint equals exactly ½ of a quart.

A gallon is a traditional unit of liquid volume, derived from the Roman *galeta*, which originally meant a pailful. Gallons of various sizes have been used in Europe ever

since Roman times. In the United States, the liquid gallon is equal to the old English wine gallon, which originated in medieval times but was not standardized until 1707, during the reign of Queen Anne.

Customary Unit for Capacity
8 fluid ounces (fl oz) = 1 cup (c)
2 cups = 1 pint (pt)
4 cups = 1 quart (qt)
4 quarts = 1 gallon (gal)
2 pints = 1 quart
8 pints = 1 gallon

- Change larger to smaller units by multiplying

  2 quarts = ? pints
  2 x 2 (2 pints to a quart) = 4 pints

- Change smaller to larger units by dividing

  12 feet = ? yards
  12 ¸ 3 (3 feet to a yard) = 4 yards

Sometimes you have to add or subtract measurements that contain different units. One way to add and subtract these measurements is to regroup.

Example 7 ft 10 in + 4 ft 5 in

Step 1 Line up the measurements, putting like measurements under like units.

$$\begin{array}{r} 7 \text{ ft } 10 \text{ in} \\ +\ 4 \text{ ft } \ 5 \text{ in} \\ \hline \end{array}$$

Step 2 Add the inches and add the feet.

$$\begin{array}{r} 7 \text{ ft } 10 \text{ in} \\ +\ 4 \text{ ft } \ 5 \text{ in} \\ \hline 11 \text{ ft } 15 \text{ in} \end{array}$$

Step 3 Change the inches to feet and inches.

$$15 \text{ in} = 1 \text{ ft } 3 \text{ in}$$

Step 4 Rewrite the total.

$$\begin{array}{l} 11 \text{ ft} + 15 \text{ in} \\ 11 \text{ ft} + 1 \text{ ft} + 3 \text{ in} \\ 12 \text{ ft } 3 \text{ in} \end{array}$$

Answer: 12 feet 3 inches

Example 2 13 pounds 4 ounces – 9 pounds 17 ounces

Step 1 Line up the measurements, putting like units under like units.

$$\begin{array}{r} 13 \text{ lb } \ 4 \text{ oz} \\ -\ 9 \text{ lb } 17 \text{ oz} \\ \hline \end{array}$$

Step 2 You have to borrow. Think of 13 lb as 12 lb 16 oz. Then rewrite 13 1b 4 oz as 12 lb 20 oz.

$$\begin{array}{r} 13 \text{ lb } 4 \text{ oz} \\ -\ 9 \text{ lb } 17 \text{ oz} \\ \hline \end{array}$$

$$\begin{array}{r} 12 \text{ lb } 20 \text{ oz} \\ -\ 9 \text{ lb } 17 \text{ oz} \\ \hline \end{array}$$

Step 3 Subtract the pounds and subtract the ounces.

$$\begin{array}{r} 12 \text{ lb } 20 \text{ oz} \\ -\ 9 \text{ lb } 17 \text{ oz} \\ \hline 3 \text{ lb } 3 \text{ oz} \end{array}$$

Answer: 3 pounds 3 ounces

To multiply a measurement times a number, first perform the operation and then change the units. To divide a measurement by a number, first change the units and then perform the operation.

Example Multiply 6 quarts 2 cups by 5.

Step 1 Write the problem.

$$\begin{array}{r} 6 \text{ qt } 2 \text{ c} \\ \times \quad 5 \\ \hline \end{array}$$

Step 2 Multiply 5 times the number of cups and multiply 5 times the number of quarts.

$$\begin{array}{r} 6 \text{ qt } 2 \text{ c} \\ \times \quad 5 \\ \hline 30 \text{ qt } 10 \text{ c} \end{array}$$

Step 3 One quart is 4 cups, so replace 10 cups with 2 quarts and 2 cups.

$$30 \text{ qt } 10 \text{ c} = 30 \text{ qt} + 2 \text{ qt} + 2 \text{ c}$$
$$= 32 \text{ qt } 2 \text{ c}$$

Answer: 32 quarts 2 cups

Example 2 Divide 9 yards 1 foot by 4.

Step 1 Write the problem.

$$\frac{9 \text{ yd } 1 \text{ ft}}{4} = ?$$

Step 2 Change the numerator to feet.

$$9 \text{ yd } 1 \text{ ft} = 27 \text{ ft} + 1 \text{ ft} = 28 \text{ ft}$$

Step 3 Rewrite the problem.

$$\frac{9 \text{ yd } 1 \text{ ft}}{4} = \frac{28 \text{ ft}}{4} = ?$$

Step 4 Divide. Then change back to yards and feet.

$$\begin{aligned} \frac{28 \text{ ft}}{4} &= 7 \text{ ft} \\ &= 6 \text{ ft} + 1 \text{ ft} \\ &= 2 \text{ yd } 1 \text{ ft} \end{aligned}$$

Answer: 2 yards 1 foot

1. Complete the following:

28 ft = _____ in	**_____ft = 28 yd**	**_____yd = 70 mi**
_____ft = 432 in	**48 ft = _____yd**	**_____ yd = 28160 ft**
4 ft = _____ in	**_____ft = 58 yd**	**_____yd = 59 mi**
_____ft = 348 in	**27 ft = _____yd**	**_____ yd = 24640 ft**
77 ft = _____ in	**_____ft = 82 yd**	**44 mi = _____ ft**
_____ft = 492 in	**93 ft = _____yd**	**_____ yd = 7040 ft**
3 ft = _____ in	**_____ft = 44 yd**	**74 mi = _____ ft**

_____ft = 360 in	24 ft = _____yd	89760 yd = _____ mi

2. Solve the following:

a. 7 ft 11 in
+1 ft 1 in

b. 1 yd 1 ft
+5yd 2 ft

c. 9 ft 7 in
+6 ft 7 in

d. 1 yd 2 ft
+2 yd 1 ft

e. 19 ft 5 in
- 7 ft 6 in

f. 11 yd 1ft
- 4 yd 1ft

g. 17 ft 2 in
-13 ft 3 in

h. 18 yd 1ft
- 2 yd 1ft

i. 16 ft 7 in
-12 ft 9 in

3. Solve the following:

a. Sid is decorating Connell Park for a party. The area that he needs is a rectangular shape of 38ft 3in by 23ft 8in. Find the length of the string that he needs to set up a border around the area?

b. The length of the red ribbon is 4 yd 2 ft. The length of the blue ribbon is 6 yd 2 ft. What is the total length of both the ribbons?

4. Solve the following:

64 lb = _____ oz	_____ lb = 272 oz
_____ T = 152000 lb	7 T = _____ lb
62 lb = _____ oz	_____ lb = 176 oz
_____ T = 120000 lb	12 T = _____ lb
83 lb = _____ oz	_____ lb = 80 oz
_____ T = 186000 lb	19 T = _____ lb
11 lb = _____ oz	_____ lb = 272 oz
_____ T = 182000 lb	8 T = _____ lb
57 lb = _____ oz	_____ lb = 160 oz
_____ T = 6000 lb	13 T = _____ lb

5. Solve the following:

a. 23 lb 11 oz
+1 lb 6 oz

b. 15 T 1005 lb
+ 5T 1682 lb

c. 10 lb 5 oz
- 7lb 15 oz

d. 3 lb 4 oz
-2lb 4 oz

e. 8 T 335 lb
-5 T 444 lb

6. Solve the following:

a. If James removes 6 pounds 4 ounces from a container that weighs 18 pounds 12 ounces, how much is left?

b. A box of detergent weighs 40 pounds 10 ounces. Joe wants to put it into 5 equal packages. How much should each package weigh?

7. Fill in the blanks:

_____ fl oz = 28c	184 fl oz = _____ c
4 pt = _____ c	_____ pt = 22 c
10 qt = _____ pt	_____ qt = 20 pt

12 gal = _____ qt	48 qt = _____ gal
_____ fl oz = 29c	160 fl oz = _____ c
8 pt = _____ c	_____ pt = 56 c
20 qt = _____ pt	_____ qt = 28 pt
21 gal = _____ qt	84 qt = _____ gal

8. Solve the following:

a. 6 c 5 fl oz
+8 c 7 fl oz

b. 8 gal 1 qt
+7 gal 1 qt

c. 7 c 4 fl oz
- 1 c 6 fl oz

d. 8 c 1 fl oz
- 6 c 6 fl oz

e. 5 c 2 fl oz
-3 c 5 fl oz

f. 7 gal 3 qt
- 4 gal 3 qt

g. 8 gal 1 qt
-5 gal 1 qt

h. 9 gal 3 qt
- 4 gal 3 qt

9. Solve the following:

a. If Joe starts with 2 gallons 3 quarts and adds 2 gallons 2 quarts, how much total liquid does he have?

b. Harold brought 2 gallons and 6 cups of apple cider to a party. If there were 11 people at the party, how many cups could each person have?

10. Convert the following

_____ lb = 17.92 T	4.5 c = _____ fl oz
_____ yd = 5.52 mi	_____ qt = 11.25 gal
54000 lb = _____ T	_____ ft = 708 in
4.25 ft = _____ in	_____ gal = 268 qt
_____ oz =1.19 lb	21120 ft = _____ mi

_____ yd = 18.83 mi	_____ gal = 128 qt
_____ lb = 18.01 T	5.08 ft = _____ in
_____ ft = 15 yd	_____ qt = 10.75 gal

11. Solve the following:

a. Tom has an 8-quart coffee maker. How many cups of coffee will it make?

b. A can of soup weighs 22 ounces. How many pounds is that?

c. George decided to plant shrubs 1 foot apart across the front of his house. His yard is 66 yards wide. How many shrubs will he need?

Measuring Temperature

About 300 years ago, German physicist Gabriel Daniel Fahrenheit (1686 – 1736) invented a scale for measuring heat. His scale is still used today on thermometers, oven dials, water heaters, and thermostats.

Fahrenheit set 0° as the coldest temperature he could conveniently achieve using an ice and salt mixture, and he intended to set 100° as the temperature of the human body. (He was off a little there; normal temperature for humans is between 98 °F and 99 °F or 37 °C.) On this scale, the freezing point of water turned out to be about 32 °F and the boiling point about 212 °F. Eventually the scale was precisely defined by these two temperatures.

1°F equals 5/9 °C, but in converting between scales we have to be careful to adjust the zero points as well. To convert a temperature in °F to the Celsius scale, we must first subtract 32° and then multiply by 5/9. In the other direction, to convert a temperature in °C to the Fahrenheit scale, we must first multiply by 9/5 and then add 32°. The Celsius scale is now used everywhere outside the United States, so only Americans need to remember these formulas.

Customary Measurement

Answer Key for Exercises

1.

336 in	84 ft	123200 yd
36 ft	16 yd	9386 2/3 yd
48 in	174 ft	103840 yd
29 ft	9 yd	8213 1/3 yd
924 in	246 ft	232320 ft
41 ft	31 yd	2346 2/3 yd
36 in	132 ft	390720 ft
30 ft	8 yd	51 mi

2.

a. 9 ft **b.** 7 yd **c.** 16 ft 2 in **d.** 4 yd **e.** 11 ft 11 in **f.** 7 yd **g.** 3 ft 11 in **h.** 16 yd **i.** 3 ft 10 in

3.

a. 123 ft 10 in **b.** 11 yd 1 ft

4.

1024 oz	17 lb
76 T	14000 lb
992 oz	11 lb
60 T	24000 lb
1328 oz	5 lb

93 T	38000 lb
176 oz	17 lb
91 T	16000 lb
912 oz	10 lb
3 T	26000 lb

5.

a. 25 lb 1 oz **b.** 21 T 687 lb **c.** 2 lb 6 oz **d.** 1 lb **e.** 2 T 1891 lb

6.

a. 12 lb 8 oz **b.** 8 lb 2 oz

7.

224 fl oz	23 c
8 c	11 pt
20 pt	10 qt
48 qt	12 gal
232 fl oz	20 c
16 c	28 pt
40 pt	14 qt
84 qt	21 gal

8.

a. 15 c 4 fl oz **b.** 15 gal 2 qt **c.** 5 c 6 fl oz **d.** 1 c 3 fl oz **e.** 1 c 5 fl oz **f.** 3 gal **g.** 1 c 5 fl oz **h.** 5 gal

9.

a. 5 gal 1 qt **b.** 3 5/11 cups

10.

35840 lb	36 fl oz
9715.2 yd	45 qt
27 T	59 ft
51 in	67 gal
19.04 oz	4 mi
33140.8 yd	32 gal
36020 lb	60.96 in
45 ft	43 qt

11.

a. 32 cups **b.** 1 3/8 lb **c.** 198 shrubs