CHAPTER XI.

COMPOUND NUMBERS.

163. Use of Different Units for the same kind of Quantity.—In measuring a great variety of distances, it is an advantage to have different units of distance, some large, some small. Thus, we measure the dimensions of a window pane in *inches*, the length of a man's jump in *feet*, the distance between two cities, as between New York and Philadelphia, in *miles*. Similarly, in weighing objects, it is convenient to have different units of weight. It would be inconvenient, if not impossible, to weigh gold by the ton, and coal by the ounce.

164. Measurement may be defined as the process of finding how many times a given quantity contains another given object or quantity of the same kind, taken as a unit.

Thus, to measure a mass of sugar, is to find how many times a certain mass of sugar, called a pound, must be repeated in order to make up the given mass.

Hence, it is evident that, in measuring large objects, it is convenient to have large units; in measuring small objects, it is convenient to have small units.

165. Compound Numbers.—In measuring a quantity it is often useful to use two or more units of different sizes, but of the same general class. Thus, in measuring the distance which an athlete jumps, we first measure the number of feet in the jump, then the number of inches, if any, in the remainder of the jump, obtaining 19 feet 7 inches say, as the entire jump.

Similarly, the length of a man's life is expressed in terms

of several units of time, as 59 years 8 months and 12 days, for instance.

A **compound number** is a number expressed in terms of several units of the same class. Exs. 19 feet 7 inches; 59 years 8 months 12 days.

A **simple number** is a number expressed in terms of a single unit, as 138 inches.

166. Relative Value of Compound Numbers and Simple Numbers. Reductions.—When a given magnitude is expressed as a compound number it is often easier to form a definite conception of it than when it is expressed as a simple number. Thus, it is much easier to form a definite conception of 19 feet 7 inches, than of 235 inches; similarly, of 59 years 8 months 12 days, than of 21787 days.

On the other hand, if a magnitude be expressed as a simple number, it is much easier to operate with it, that is, to multiply, divide, etc. Thus, if it be required to find the area of a room that is 14 feet 8 inches long and 12 feet 3 inches wide, it is best to reduce the length and breadth of the room either to feet or to inches, before multiplying them.

Reduction descending is the process of reducing a number expressed in several units to an equivalent number expressed in a single small unit, as reducing 19 feet 7 inches to 235 inches.

Reduction ascending is the process of reducing a simple number to an equivalent number expressed in terms of higher units, as reducing 21787 days to 59 years 8 months 12 days.

These processes will be illustrated in connection with each table of units given in this chapter.

167. The **different classes of units** in common use are those of:

1. **Weight.**
2. **Length.**
3. **Area.**
4. **Volume (and capacity).**
5. **Value.**
6. **Time.**
7. **Angular magnitude (longitude).**
8. **Miscellaneous units.**

EXERCISE 63.

ORAL.

1. What unit would naturally be used in weighing hay? Tea? Flour? A rock? Ginger? Coffee?

2. What unit of length would be used in measuring the distance between two houses on same street? Between the floor and ceiling of a room? Between the walls of a room? Distance around your waist? Your height?

3. What unit of length is used in measuring the length of a railroad? Of a flag-pole? Of a roll of carpet? Of a man's arm?

4. What unit of area is employed in measuring land? Plastering?

5. What unit of capacity is used in the measurement of milk? Molasses? Potatoes? Strawberries? Beans? Apples?

6. What unit in measuring illuminating gas?

7. What unit of money is used in paying for a horse? A newspaper? A farm? A pencil?

8. What units of time are used in expressing your age? The age of the world? Of a baby? In stating time of an eclipse?

9. What unit is first used in measuring the length of a board? In completing the measurement?

10. What combination of units is used in expressing the time required to run a mile? To run a hundred yards? What units, in hiring a laborer?

11. In paying a bill of $28.75, what combination of units is used (bills and coins)?

WEIGHT.

168. I. **Avoirdupois weight** is used in weighing all ordinary objects, the exceptions being the precious metals, jewels, and drugs when retailed.

The primary unit in avoirdupois weight is **pound avoirdupois**, which is determined by the weight of a certain piece of metal kept in the government archives (see Art. 171).

AVOIRDUPOIS WEIGHT.

16 drams (dr.)	= 1 ounce (oz.).
16 oz.	= 1 pound (lb.).
100 lbs.	= 1 hundred-weight (cwt.).
20 cwt.	= 1 ton (T.).

The pound avoirdupois is also regarded as made up of 7000 grains.

The long ton, or 2240 pounds, is used in weighing objects in the United States Custom Houses, and in wholesale transactions in coal and iron.

Ex. 1. How many oz. in 7 T. 8 cwt. 63 lb. 14 oz.?

SOLUTION.

7 T. = 20 cwt. × 7 = 140 cwt.
140 cwt. + 8 cwt. = 148 cwt.
148 cwt. = 100 lb. × 148 = 14800 lb.
14800 lb. + 63 lb. = 14863 lb.
14863 lb. = 16 oz. × 14863 = 237808 oz.
237808 oz. + 14 oz. = 237822 oz., *Result.*

This is an example of *reduction descending*, or of reducing a compound number to an equivalent simple number in terms of the lowest unit in the given compound number.

In general, to reduce a compound number by reduction descending, *in the given compound number take the number of highest denomination; multiply it by the number of units of the next lower kind which equal one of the higher units, and add to the product the given number of units of the second kind; proceed similarly till all the units have been reduced to the lowest unit.*

Ex. 2. How many tons, hundred-weight, and pounds in 9382 pounds of coal?

SOLUTION.

$$9382 \text{ lb.} = \frac{9382}{100} \text{ cwt.} = 93 \text{ cwt.} + 82 \text{ lb.}$$

$$93 \text{ cwt.} = \frac{93}{20} \text{ T.} = 4 \text{ T.} + 13 \text{ cwt.}$$

4 T. + 13 cwt. + 82 lb., *Result.*

This is an example of *reduction ascending*, or of converting a simple number into a compound number containing higher denominations.

In general, in reduction ascending, *divide the given number by the number of units of the same kind which equals a unit of the next highest kind, and set aside the remainder; divide the quotient in a like manner and so proceed till no further division is possible*

EXERCISE 64.

Reduce:

1. 3 t. 13 cwt. 70 lbs. 10 oz. to ounces.
2. 5 t. 80 lbs. to pounds.
3. 6 t. 1 cwt. 15 oz. to ounces.
4. 15 cwt. 75 lbs. 11 oz. to ounces.
5. 45 t. 17 cwt. 90 lbs. to pounds.
6. 120650 oz. to higher denominations.
7. 236949 oz. to higher denominations.
8. 13280 lbs. to higher denominations.
9. 332805 oz. to higher denominations.
10. 289135 oz. to higher denominations.

Change:

11. 70 t. 48 cwt. 60 lbs. 6 oz. to ounces.
12. 30854 oz. to higher denominations.
13. How many firkins of butter each weighing 31 lbs. 4 oz. will be required to weigh a ton?
14. If there are 9 oz. of iron in a man's blood, how many men would supply iron enough to make a 27-lb. ball?
15. A cook uses 7 pounds 8 ounces of flour at every baking. How many bakings can she get out of 3 cwt. 30 lbs. of flour?
16. The average weight of each book in a library is 2 lbs. 5 oz. What would be the entire weight of the 8560 volumes?

EXERCISE 65.

ORAL.

1. How many ounces in 5 pounds? In 10½ pounds?
2. How many tons in 1000 pounds? In 60000 lbs.?
3. How many pounds in 6 tons? In 15 tons? In 80 ounces?
4. If butter sells for 2 cents an ounce, what will be the price per pound?
5. When flour is worth 2 cents per pound, what will 2 hundred-weight cost? What will 8 ounces cost?
6. How many pounds in ¼ ton? In ⅖ ton? In ¾ hundred-weight? In 1½ hundred-weight? In 40 ounces? In 100 ounces?

169. II. **Troy weight** is used in weighing gold, silver, and jewels.

The primary unit is a *pound Troy*, or 5760 grains.

TROY WEIGHT.

24 grains (gr.)	= 1 pennyweight (pwt. or dwt.).
20 pwt.	= 1 ounce (oz.).
12 oz.	= 1 pound (lb.).

Diamonds and other jewels are also weighed in terms of another unit, the *carat*. The carat = 3⅛ grains. (The term carat is also used in another sense, viz.: to express the parts of gold contained by a given metal alloy. In this sense one carat means one twenty-fourth part. Gold 18 carats fine contains 18 parts of pure gold and 6 parts of some other metal.)

EXERCISE 66.

Reduce to grains:

1. 3 oz. 4 pwt. 20 gr.
2. 7 oz. 15 pwt. 18 gr.
3. 5 lb. 8 oz. 10 pwt. 9 gr.
4. 8 lb. 9 oz. 12 gr.
5. 8 lb. 5 pwt. 22 gr.
6. 12 lb. 6 oz. 18 pwt.

Reduce to higher denominations:

7. 15136 gr.
8. 5117 gr.
9. 954 pwt.
10. 31701 gr.
11. 46474 gr.
12. 27009 gr.

13. If a silver medal weigh 6 oz. 18 pwt., what will be the weight of 5 such medals? How many will it take to weigh 6 lbs. 3 oz. 18 pwt.?

170. III. **Apothecaries' Weight** is used in mixing and selling drugs and medicines at retail (these being purchased by druggists at wholesale by avoirdupois weight).

The primary unit is the same as in Troy weight (5760 grains), but it is divided somewhat differently.

APOTHECARIES' WEIGHT.

20 grains (gr.)	= 1 scruple (℈).
3 scruples	= 1 dram (ʒ).
8 drams	= 1 ounce (℥).
12 ounces	= 1 pound (lb.).

EXERCISE 67.

Reduce to grains:

1. 5 ʒ 3 ʒ 2 ℈ 8 gr.	*4.* 6 ʒ 1 ℈ 16 gr.
2. 3 lb. 8 ʒ 6 ʒ 10 gr.	*5.* 5 lb. 10 ʒ 5 ʒ 2 ℈.
3. 2 lb. 5 ʒ 1 ℈ 15 gr.	*6.* 10 lb. 3 ʒ 12 gr.

Change to higher denominations:

7. 5148 gr.	*9.* 8665 gr.	*11.* 23897 gr.
8. 1691 gr.	*10.* 875 ℈.	*12.* 40370 gr.

171. Relation of the Different Systems of Units of Weight.—In the United States the fundamental unit of weight is the weight of a certain piece of brass in the custody of the United States Mint.

This is the Troy (and apothecaries') pound, and is regarded as made up of 5760 grains. From this the *avoirdupois* pound is derived by taking the weight of 7000 grains. Hence, the only unit in common to avoirdupois weight and Troy weight is the *grain*. In Troy weight and apothecaries' weight the *pound*, *ounce*, and *grain* are the same, but the other units are different.

In Great Britain the standard of weight is the weight of a certain piece of platinum kept in the Exchequer Office. This weight is called the Imperial Pound. The Troy pound is derived from it.

EXERCISE 68.

1. How many grains in an ounce avoirdupois? Ounce Troy? Ounce apothecaries'?

2. How many grains in a dram apothecaries'? Dram avoirdupois?

3. Which is heavier, and how much, a pound avoirdupois or a pound Troy? An ounce avoirdupois or an ounce Troy?

4. What is the gain in buying drugs by avoirdupois and selling them at the same rate apothecaries' weight? Buying gold by avoirdupois and selling by Troy weight?

5. How many avoirdupois pounds in 175 Troy pounds?

MEASURES OF LENGTH.

172. I. **Long Measure.**—The primary unit of length in the United States and Great Britain is the *yard*. This is the distance between two marks on a bar of metal kept in the Exchequer Office of Great Britain.

From the yard are derived the following units of length:

LONG MEASURE.

12 inches (in.) = 1 foot (ft.).
3 ft. = 1 yard (yd.).
5½ yd. or 16½ ft. = 1 rod (rd.).
320 rds. = 1 mile (mi.).

Rods are also called *poles* or *perches*.
A *furlong* = 40 rods; hence, 8 furlongs = 1 mile.
Civil engineers often divide the foot into tenths instead of inches.

Ex. 1. Reduce 5 mi. 208 rd. 2 yd. 1 ft.

SOLUTION.

5 mi. = 320 rd. × 5 = 1600 rd.
1600 rd. + 208 rd. = 1808 rd.
1808 rd. = 5½ yd. × 1808 = 9944 yd.
9944 yd. + 2 yd. = 9946 yd.
9946 yd. = 3 ft. × 9946 = 29838 ft.
29838 ft. + 1 ft. = 29839 ft., *Result.*

Ex. 2. Reduce 29839 feet to higher denominations.

SOLUTION.

$29839 \text{ ft.} = \frac{29839}{3} \text{ yd.} = 9946 \text{ yd.} + 1 \text{ ft.}$

$9946 \text{ yd.} = \frac{9946 \times 2}{11} \text{ rd.} = 1808 \text{ rd.} + 4 \text{ half yd. (or 2 yd.).}$

$1808 \text{ rd.} = \frac{1808}{320} \text{ mi.} = 5 \text{ mi.} + 208 \text{ rd.}$

5 mi. 208 rd. 2 yd. 1 ft., *Result.*

Dividing 9946 yards by $5\frac{1}{2}$ is the same as dividing it by $\frac{11}{2}$. This, in effect, consists in reducing 9946 yards to 19892 half yards, and dividing by 11. This gives 1808 rods with 4 half yards, or 2 yards, as a remainder.

173. II. **Surveyors' linear measure** is used by surveyors in measuring the dimensions of tracts of land. In it the units are chosen with a view to determining the area of the tract measured, in an advantageous way. See Art. 177.

SURVEYORS' LINEAR MEASURE.

7.92 inches = 1 link (li.).
100 li. = 1 chain (ch.).
80 ch. = 1 mile.

Hence, 1 ch. = 4 rds. = 66 ft. = 792 in.

EXERCISE 69.

Reduce to feet:

1. 44 rds. 3 yds. 2 ft.
2. 2 mi. 125 rds. 5 yds.
3. 3 mi. 250 rds. 4 yds. 1 ft.
4. 4 mi. 3 yds. 2 ft.

Reduce to inches:

5. 36 rds. 4 yds. 2 ft. 10 in.
6. 3 rds. 3 yds. 1 ft. 7 in.
7. 2 mi. 170 rds. 5 yds. 6 in.
8. 3 mi. 240 rds. 1 ft. 8 in.

Reduce to higher denominations:

9. 214 in.
10. 1710 in.
11. 14198 ft.
12. 380341 in.
13. 278222 in.
14. 504009 in.

Reduce to links:

15. 45 rds.
16. 3 miles.
17. 1 yd. 3.6 in.

18. How many rails 30 feet long will be required to build 7 miles of railroad (single track)?

19. What is the cost of building 30 miles 250 rods of road at $2.25 a yard?

20. How many panels of fence, each 2 yds. 1 ft. 6 in., will be required along the sides of a lane 1 mi. 202 rds. 4 yds. long?

21. Along the side of a room mark off 1 ft., 3 ft., 8 ft., 1 yd., 3 yds., 1 rd., 3 yds. 2 ft., 2 yds. 1 ft. 8 in.

EXERCISE 70.

ORAL.

1. How many inches in 6 ft.? In $7\frac{1}{2}$ ft.? In 1 yd.?
2. How many feet in 5 yds.? In 2 rds.? In a mile? In 60 in.?
3. How many feet in 125 in.? In $3\frac{1}{2}$ yds.? In 1 rd. 2 yds.?
4. What part of a foot is 3 in.? 4 in.? 6 in.? 8 in.? 9 in.? 10 in.?
5. What part of a yard is 9 in.? 12 in.? 18 in.? 24 in.? 27 in.?
6. What part of a mile is 40 rds.? 80 rds.? 200 rds.? 280 rds.?
7. How many chains are there in 400 rds.? In 110 rds.?
8. How many inches are there in 50 links? In 80 li.? In 6 li.?

MEASURES OF SURFACE.

174. A **surface** has two dimensions, length and breadth. In measuring surfaces, or square measure, the primary unit is a flat square, each of whose sides is 1 yard. It is sometimes more convenient to use other units of surface, as a square, each of whose sides is 1 inch, or 1 foot. These units may be regarded as derived from the primary unit, the square yard.

A surface is measured by determining the number of times the unit of surface must be used to make up the given surface.

175. The **area** of a surface is the number of times the unit of surface is contained in the given surface.

Thus, if a rectangle be 7 inches long and 5 inches wide, it contains 35 square inches, and its area is said to be 35 square inches.

It is evident that in a rectangle, whose sides contain an exact number of linear units, the number of units in the area will equal the number of linear units in one dimension multiplied by the number of linear units in the other dimension (see Figure, p. 53). For in such a rectangle the entire number of small unit squares is equal to the number of them in each row

multiplied by the number of rows, which equals the number of linear units in the length multiplied by the number in the breadth.

Hence, to find the area of a rectangle, *multiply the length by the breadth.*

176. I. **Surface or square measure.**

SQUARE MEASURE.

144 square inches (sq. in.)	= 1 square foot (sq. ft.).
9 sq. ft.	= 1 square yard (sq. yd.).
$30\frac{1}{4}$ sq. yds.	= 1 square rod (sq. rd.).
160 sq. rds.	= 1 Acre (A.).
640 A.	= 1 square mile.

177. II. In **Surveyors' square measure** the primary unit of surface is the square chain, that is, a square piece of land, each side of which is 1 chain, or 66 feet.

SURVEYORS' SQUARE MEASURE.

16 sq. rds. = 1 sq. ch.
10 sq. ch. = 1 acre.

Hence, 1 acre = 10 sq. ch. = 160 sq. rds.

The advantage in using surveyor's measure in measuring land lies in the fact that, after the number of square chains in a piece of land have been determined, the *number of acres can be determined by simply dividing the number of square chains by 10;* that is, by moving the decimal point one place to the left.

EXERCISE 71.

Reduce:

1. 6 sq. rds. 4 sq. yds. 5 sq. ft. to sq. ft.
2. 2 A. 56 sq. rds. 10 sq. yds. to sq. ft.
3. 3 A. 24 sq. yds. 7 sq. ft. to sq. ft.
4. 8 sq. yds. 3 sq. ft. 100 sq. in. to sq. in.
5. 3 sq. rds. 16 sq. yds. 25 sq. in. to sq. in.
6. 4 A. 3 sq. yds. 4 sq. ft. to sq. in.

Reduce to higher denominations:

7. 17188 sq. yd.	*9.* 944720 sq. in.	*11.* 117804 sq. ft.
8. 16567 sq. ft.	*10.* 39725 sq. in.	*12.* 3657930 sq. in.

13. How many sq. ch. in one sq. mi.? In 800 sq. rds.?
14. Change 15000 sq. ch. to higher denominations.
15. Draw upon the blackboard a sq. ft. and subdivide it into sq. in. How many are there?
16. Draw a sq. yd. and subdivide it into sq. ft. How many?

EXERCISE 72.

ORAL.

1. How many square feet in 3 sq. yds.? In $5\frac{1}{3}$ sq. yds.? In 2 sq. rds.?
2. How many square inches in 4 sq. ft.? In $2\frac{1}{2}$ sq. ft.? In 1 sq. yard?
3. How many acres in 2 sq. miles? In 800 sq. rds.?
4. What is the difference between a square foot and a square yard?
5. What is meant by 6 in. square? 10 ft. square? 3 yards square?
6. What is the difference between 3 sq. ft. and 3 feet square? Between 6 sq. yds. and 6 yards square?
7. How many square inches in the lid of a box 1 ft. 3 in. square? In another, 1 ft. 4 in. square? In another $\frac{2}{3}$ ft. square?

MEASURES OF VOLUME AND CAPACITY.

178. A **solid** has three dimensions: length, breadth, and thickness.

A **cube** is a solid bounded by six equal squares.

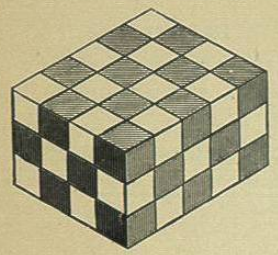
The **primary unit of volume** is a cube, each of whose edges is 1 yard, and is called a **cubic yard.**

It is sometimes more convenient to use other derived units of volume, as 1 cubic inch, or 1 cubic foot.

A solid is measured by determining how many times the unit of volume must be taken to make up the given solid.

The **cubic contents,** or volume, of a solid is the number of times the unit of volume is contained in the given solid.

It is evident that in a box-shaped, or rectangular, solid, each of whose edges contains an exact number of linear units, the number of units of volume may be readily obtained from the number of linear units in the edges. Thus, if we have such a solid whose edges are 3, 4, and 5 inches, and the solid be divided into small unit cubes, each edge of which is 1 inch, each layer will contain 4×5 cubic inches; and as there are 3 layers the entire solid will contain $3 \times 4 \times 5$ (or 60) cubic inches.



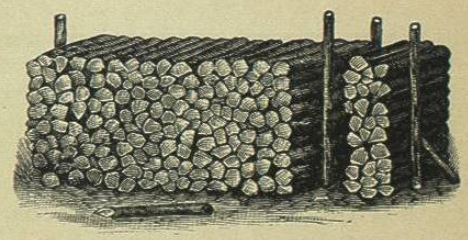
Hence, in order to determine the *volume of a rectangular solid*, instead of cutting the solid up into little cubes, and counting them, we substitute the less labor of making linear measurements of the three edges, and taking the *product of the length by the breadth by the thickness.*

179. I. **Cubic Measure** in general.

CUBIC MEASURE.

1728 cubic inches (cu. in.) = 1 cubic foot (cu. ft.).
27 cu. ft. = 1 cubic yard (cu. yd.).

180. II. **Wood Measure.**—In measuring wood the *cord* is the primary unit used. A cord is a pile of wood 8 feet long, 4 feet wide, and 4 feet high. A cord foot is that part of a cord which is 1 foot long.



WOOD MEASURE.

16 cubic feet = 1 cord foot.
8 cord feet = 1 cord.
Or 128 cubic feet = 1 cord.

EXERCISE 73.

Reduce:

1. 2 cu. yds. 5 cu. ft. 200 cu. in. to cu. in.
2. 5 cu. yds. 20 cu. ft. to cu. ft.
3. 7 cd. 4 cd. ft. to cu. ft.
4. 3 cd. 5 cd. ft. 10 cu. ft. to cu. ft.

Reduce to higher denominations:

5. 166413 cu. in. | *6.* 2046 cu. ft. | *7.* 3455 cu. ft.

8. How many cubic yards in a cord? How many cords in 432 cu. yds.?

9. Measure the edges of a crayon box and compute its volume.

10. How many cords in a pile of wood whose dimensions are 6, 10 and 32 feet?

EXERCISE 74.

ORAL.

1. How many cu. in. in half a cubic foot? In $\frac{3}{4}$ cu. ft.? In 2 cu. ft.?
2. How many cu. ft. in $\frac{1}{3}$ cu. yd.? In 3 cu. yds.? In $2\frac{2}{3}$ cu. yds.?
3. How many cu. ft. in $\frac{1}{2}$ cord? In $\frac{1}{4}$ cord? In $\frac{3}{8}$ cord?
4. What is the volume of a box whose dimensions are 3, 5 and 6 inches? Or another 4, 6 and 7 feet?
5. What is the volume of a 3-in. cube? Of a 4-ft. cube?
6. What is the difference between a 5-in. cube and 5 cu. in.? Between a 2-ft. cube and 2 cu. ft.?

181. Measure of Capacity.—For fluids and loose objects, as grain, fruit, etc., it is found convenient to use other units of volume or capacity, as the pint, gallon, bushel, etc., each of which, however, can be expressed as a certain number of cubic inches.

In dealing with such materials it is usually not convenient to make linear measurements, and a given material is measured directly by counting the number of times it will fill a unit vessel. Wherever possible, however, the method of linear measurements and of computations from these is to be preferred.

182. I. **In Dry Measure** the fundamental unit is the bushel, which contains 2150.42 cu. in.

DRY MEASURE.

2 pints (pt.) = 1 quart (qt.).
8 qts. = 1 peck (pk.).
4 pks. = 1 bushel (bu.).

183. II. **In Liquid Measure** the fundamental unit is the gallon, containing 231 cu. in.

LIQUID MEASURE.

4 gills (gi.) = 1 pint (pt.).
2 pts. = 1 quart (qt.).
4 qts. = 1 gallon (gal.).
31½ gals. = 1 barrel (bbl.).
63 gals. = 1 hogshead (hhd.).

Barrels and hogsheads in common use often vary greatly from the standard size.

184. III. **Apothecaries' Fluid Measure.**

60 minims, or drops (♏) = 1 fluid dram (f℥).
8 fluid drams = 1 fluid ounce (f ℥).
16 fluid ounces = 1 pint (O).
8 fluid pints = 1 gallon (Cong.).

A common glass or teacup contains 8 fluid ounces.
What is called a *tablespoonful* contains about ½ a fluid ounce.
What is called a *teaspoonful* contains about ⅛ a fluid ounce.

EXERCISE 75.

Reduce to pints:

1. 5 bu. 3 pks. 6 qts. | *3.* 2 bbl. 23 gal. 1 pt.
2. 3 bbls. 2 gal. 3 qt. 1 pt. | *4.* 10 bu. 2 pk. 6 qt. 1 pt.

Reduce to quarts:

5. 8 bu. 2 pk. 5 qt. | *6.* 3 hhd. 18 gal. 3 qt.

Reduce to higher denominations:

7. 894 gi. | *9.* 712 qt. l.-m. | *11.* 3291 gi.
8. 233 pt. d.-m. | *10.* 319 pt. d.-m. | *12.* 1629 pt. d.-m.

13. How many cu. in. in a standard barrel? In 5 bushels?
14. How many cu. ft. in 12 bushels?
15. How many cu. in. in a dry qt.? In a liquid qt.?
16. How many gallons have the same capacity as one bushel?
17. What will be the cost of 5 gal. 3 qt. 1 pt. of vinegar at 4 cents a pt.?
18. What will 10 bu. 3 pk. 6 qt. of grain cost at 3 cents a qt.?
19. How much milk at a cent a gill must be given in exchange for 2 bu. 1 pk. 5 qt. of grass seed at 10 cents a pt.?

EXERCISE 76.

ORAL.

How many:
1. Pints in a gallon? In a peck? In a bushel?
2. Quarts in a bushel? In a barrel? In 4 gal. 3 qt.?
3. Gallons in 36 qts.? In 48 qts.? In 3 bbl.?
4. Bushels in 12 pk.? In 64 qt.? In 64 pk.?
5. What part of a gallon is a qt.? A pt.? A gill?
6. What part of a bushel is a pk.? A qt.? 4 qts.? 24 qts.?
7. Which is greater, a dry pint or a liquid pint?

MEASURES OF VALUE.

185. Units of **money** are unit quantities of the precious metals, as gold and silver, which are used to measure the values of things.

Coin is the actual metal itself as weighed, shaped, and stamped by the government to form single units or combinations of units of value.

Paper money consists of engraved and printed promises to pay a certain number of units of coin to the bearer.

Currency is a general name for both coin and paper money.

186. I. **In United States money** the primary unit is the gold dollar.

10 mills = 1 cent (ct. or ¢).
10 cents = 1 dime (d.).
10 dimes = 1 dollar ($).
10 dollars = 1 eagle.

The coins in use in the United States are as follows:

Bronze: the cent.

Nickel: the five-cent piece.

Silver: the dime, quarter dollar, half dollar, and dollar.

Gold: the dollar, quarter eagle, half eagle, eagle, and double eagle.

187. II. In **English money** the fundamental unit is 1 pound, whose value in United States money is $4.8665.

4 farthings (far.) = 1 penny (d.).
12 pence = 1 shilling (s.).
20 shillings = 1 pound (£).
21 shillings = 1 guinea (G.).

The coins used in Great Britain are as follows:

Copper: penny, half-penny, farthing.

Silver: three pence, six pence, shilling, florin (2 s.), double florin (4 s.), half-crown (2½ s.), crown (5 s.).

Gold: half-sovereign (10 s.), sovereign (20 s.).

EXERCISE 77.

Reduce to farthings:

1. 6 s. 9 d. 2 far. | *3.* £16 15 s. 8 d. 3 far.
2. £10 7 s. 3 d. 1 far. | *4.* £73 13 s. 7 d. 3 far.

Reduce to higher denominations:

5. 728 cents. | *8.* 608 d. | *11.* 8493 far.
6. 3452 cents. | *9.* 755 far. | *12.* 9614 far.
7. 605 far. | *10.* 3573 far. | *13.* 15987 far.

Find the value in U. S. money of:

14. £13. | *16.* £10 6 s. | *18.* £5.8.
15. 15 s. | *17.* £65 18 s. 6 d. | *19.* £3.45.

Find the value in English money of:

20. $486.65. | *21.* $116.796. | *22.* $583.98. | *23.* $47.6917.

EXERCISE 78.

ORAL.

1. How many cents in $\$\frac{1}{4}$? In $\$\frac{1}{2}$? In $\$\frac{3}{4}$? In $\$\frac{1}{8}$? In $\$\frac{1}{5}$? In $6?

2. What part of a dollar is 10 cts.? 20 cts.? 33⅓ cts.? 37½ cts.? 50 cts.? 66⅔ cts.? 60 cts.?

3. How many shillings in 36 d.? In £5? In 8 guineas?

4. How many farthings in 8 d.? In 1 shilling? In £1? In 3 crowns?

5. What part of a pound is a crown? Of $5 is 50 cents?

6. How many pence in 3 s. 3 d.? In a pound?

188. III. In **French money** the unit is the **franc**, the value of which in U. S. money is $0.193.

100 centimes (c.) = 1 franc (f.).

In Belgium and Switzerland the unit of money is also the franc. In Italy it is the **lira**, in Spain the **peseta**, each of which has the same value as the franc.

189. IV. In **German money** the unit is the **mark**, the value of which in U. S. money is $0.238.

100 pfennige (pf.) = 1 mark (m.).

In **Austria** the unit of money is the **crown**, the value of which is $0.203.

EXERCISE 79.

Reduce to dollars:

1. 200 francs. | *3.* 60 francs 45 centimes.
2. 155 marks. | *4.* 92.65 marks.

Change to French money and to German money:

5. $75. | *6.* $123.45. | *7.* $976.80.

8. A pair of gloves cost 12 francs in Paris. How much was that in U. S. money?

9. A book sold for 32 marks in Berlin. What was its equivalent in American money?

MEASURES OF TIME.

190. The primary unit of time is the **mean solar day.** This is the average or mean interval between two successive passages of the sun across the same meridian. It is customary to make the day at any place begin at midnight.

Another natural unit of time is the *solar year*, or the time it takes the earth to make a single revolution about the sun.

TABLE OF TIME.

60 seconds (sec.) = 1 minute (min.).
60 minutes = 1 hour (h.).
24 hours = 1 day (da.).
365 days = 1 common year (yr.).
366 days = 1 leap year.
100 years = 1 century (cen.).

7 days make one week; 4 weeks make one month for many purposes. 30 days = 1 month for certain purposes.

191. The calendar. The solar year is divided into twelve months called *calendar* months. The names of these months with the number of days in each are as follows:

	Days.		Days.
1. January (Jan.)	31	*7.* July	31
2. February (Feb.)	28 or 29	*8.* August (Aug.)	31
3. March (Mar.)	31	*9.* September (Sept.)	30
4. April (Apr.)	30	*10.* October (Oct.)	31
5. May	31	*11.* November (Nov.)	30
6. June	30	*12.* December (Dec.)	31

The calendar year begins with January 1. The calendar year is also divided into 4 seasons of three months each.

The following lines, if committed to memory, will enable the pupil to recall readily the number of days in each calendar month:

Thirty days hath September,
April, June, and November.
All the rest have thirty-one,
Except the second month alone,
To which we twenty-eight assign,
Till leap year gives it twenty-nine.

The explanation of the fact that February sometimes has 28 days and sometimes 29 days is as follows: The exact length of the solar year is 365 dys. 5 hrs. 48 min. and 48 sec., which is a little less than 365¼ days. It is convenient to have each calendar year contain an exact number of days. This end is obtained by having three years in succession each containing 365 days (called common years), followed by a fourth year containing 366 days (called a leap year). Since, however, the true or solar year is a little less than 365¼ days, it is necessary to omit 3 leap years in every 400 years,

in order to keep an exact correspondence between the average calendar year and the solar year. This is done by regarding only *those century years which are divisible by four hundred as leap years.*

Thus the years 1700, 1800, 1900 are not leap years, but 2000 is a leap year.

EXERCISE 80.

Reduce to minutes:

1. 4 da. 17 hr. 50 min.
2. 1 yr. 250 da. 6 hr. 30 min.
3. 2 yr. 175 da. 18 hr. 40 min.
4. 5 yr. 60 da. 9 hr. 51 min.

Reduce to seconds:

5. 220 da. 25 min. 45 sec.
6. 315 da. 21 hr. 38 sec.

Reduce to higher denominations:

7. 57330 sec.
8. 93324 min.
9. 64240 hr.
10. 128140 sec.
11. 1052348 min.
12. 86215 hrs.

13. How many seconds in 4 wk. 5 da. 17 hr. 30 sec.?
14. How many hours in 41 wk. 6 da. 21 hr.?

How many days from:

15. May 1 to July 18?
16. June 2 to Dec. 15?
17. July 19 to Dec. 25?
18. Nov. 21 to Feb. 14?
19. Aug. 16 to Feb. 20?
20. Mar. 7 to Jan. 17?
21. Apr. 14 to Oct. 18?
22. Apr. 23 to Feb. 25?

23. Which has the least number of days, the spring months, the summer months, or the fall months?

EXERCISE 81.

ORAL.

1. How many days in 6 weeks? In 96 hours? In 3 years?
2. How many hours in 3 days? In 480 minutes? In 2 weeks?
3. Which has the greater number of days, summer or winter of 1904?
4. Which of the following years are leap years, and why?

1775, 1805, 1826, 1836, 1866, 1884, 1898, 3000.
1600, 2001, 1640, 1920, 1970, 1954, 1900, 3456.

5. What improvements could you suggest in the distribution of days in the calendar?