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Ray's New Higher Arithmetic

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RAY'S

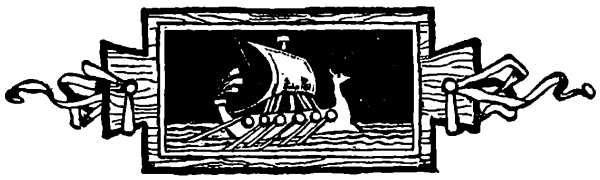
NEW HIGHER

ARITHMETIC

A REVISED EDITION OF THE HIGHER ARITHMETIC

BY

JOSEPH RAY, M. D.
Late Professor in Woodward College.



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PREFACE.

RAY'S HIGHER ARITHMETIC was published nearly twenty-five years ago. Since its publication it has had a more extensive circulation than any other similar treatise issued in this country. To adapt it more perfectly to the wants of the present and future, it has been carefully revised.

It has been the aim of the revision to make RAY'S NEW HIGHER ARITHMETIC thoroughly practical, useful, and teachable. To this end the greatest care has been given to securing concise definitions and explanations, and, at the same time, the systematic and thorough presentation of each subject. The pupil is taught to think for himself correctly, and to attain his results by the shortest and best methods. Special attention is given to modern business transactions, and all obsolete matter has been discarded.

Almost every chapter of the book has been entirely rewritten, without materially changing the general plan of the former edition, although much new, and some original matter has been introduced. Many of the original exercises are retained.

Particular attention is called to the rational treatment of the Arithmetical Signs, to the prominence given to the Metric System, and to the comprehensive, yet practical, presentation of Percentage and its various Applications. The method of combining the algebraic and geometric processes in explaining square and cube root will commend itself to teachers. The chapter on Mensuration is unusually full and varied, and contains a vast amount of useful information.

The Topical Outlines for Review will prove invaluable to both teachers and pupils in aiding them to analyze and to classify their arithmetical knowledge and to put it together so as to gain a comprehensive view of it as a whole.

Principles and Formulas are copiously interspersed as summaries, to enable pupils to work intelligently.

The work, owing to its practical character, logical exactness, and condensation of matter, will be found peculiarly adapted to the wants of classes in High Schools, Academies, Normal Schools, Commercial Schools and Colleges, as well as to private students.

The publishers take this opportunity of expressing their obligations to J. M. GREENWOOD, A. M., Superintendent of Public Schools, Kansas City, Mo., who had the work of revision in charge, and also to REV. DR. U. JESSE KNISELY, of Newcomerstown, Ohio, for his valuable assistance in revising the final proof-sheets.

CINCINNATI, *July*, 1880.

CONTENTS.

RAY'S

HIGHER ARITHMETIC.

I. INTRODUCTION.

Article 1. A **definition** is a concise description of any object of thought, and must be of such a nature as to distinguish the object described from all other objects.

2. Quantity is any thing which can be increased or diminished; it embraces number and magnitude. Number answers the question, "How many?" Magnitude, "How much?"

3. Science is knowledge properly classified.

4. The primary truths of a science are called **Principles.**

5. Art is the practical application of a principle or the principles of science.

6. Mathematics is the science of quantity.

7. The elementary branches of mathematics are Arithmetic, Algebra, and Geometry.

8. Arithmetic is the introductory branch of the science of numbers. Arithmetic as a science is composed of defini-

The **franc** (worth 19.3 cents in U. S. money) is the unit. The franc is also used in Switzerland and Belgium, and under other names, in Italy, Spain, and Greece.

TABLE.

10 millimes, marked m., make 1 centime, marked c.
10 centimes " 1 decime, " d.
10 decimes " 1 franc, " fr.

EQUIVALENT TABLE.

1 fr. = 10 d. = 100 c. = 1000 m.
1 d. = 10 c. = 100 m.
1 c. = 10 m.

REMARK.—The coins are of gold, silver, and bronze. The *gold* coins are 100, 50, 20, 10, and 5-franc pieces; they are .9 pure gold. The 20-franc piece weighs 99.55 gr. The *silver* coins are 5, 2, and 1-franc pieces, and 50 and 20-centime pieces; they are now .835 pure silver. The *bronze* coins are 10, 5, 2, and 1-centime pieces. The decime is not used in practice. All sums are given in francs and centimes, or hundredths.

German Money.

184. German Money is the legal currency of the German Empire.

The **mark,** or **reichsmark** (worth 23.8 cents in U. S. money), is the unit. The only other denomination is the pfennig (penny).

TABLE.

100 pfennige, marked Pf., make 1 mark, marked RM.

REMARK.—The coins are of gold, silver, and copper. The *gold* coins are of the value of 40, 20, 10, and 5 marks; the *silver* coins, 3, 2, and 1-mark pieces, and 50, 20, and 10 pfennige. The *copper*, 2 and 1-pfennig pieces. Gold and silver are .9 fine.

MEASURES OF WEIGHT.

185. **Weight** is the measure of the force called gravity, which draws bodies toward the center of the earth.

The standard unit of weight in the United States is the **Troy pound** of the Mint.

186. Three kinds of weight are in use,—*Troy Weight*, *Apothecaries' Weight*, and *Avoirdupois Weight*.

Troy Weight.

187. **Troy Weight** is used in weighing gold, silver, platinum, and jewels. Formerly it was used in philosophical and chemical works.

TABLE.

24 grains,	marked	gr.,	make 1 pennyweight,	marked	pwt.
20 pwt.		"	1 ounce,	"	oz.
12 oz.		"	1 pound,		lb.

EQUIVALENT TABLE.

lb.	oz.	pwt.	gr.
1 =	12 =	240 =	5760.
	1 =	20 =	480.
		1 =	24.

REMARK.—The Troy pound is equal to the weight of 22.7944 cubic inches of pure water at its maximum density, the barometer being at 30 inches. The standard pound weight is identical with the Troy pound of Great Britain.

Apothecaries' Weight.

188. **Apothecaries' Weight** is used by physicians and apothecaries in prescribing and mixing dry medicines. Medicines are bought and sold by Avoirdupois Weight.

TABLE.

20	grains,	marked gr.,	make 1	scruple,	marked ℈.
3	℈	"	1	dram,	" ʒ.
8	ʒ	"	1	ounce,	" ℥.
12	℥	"	1	pound,	" ℔.

EQUIVALENT TABLE.

℔.	℥.	ʒ.	℈.	gr.
1 =	12 =	96 =	288 =	5760.
	1 =	8 =	24 =	480.
		1 =	3 =	60.
			1 =	20.

REMARK.—The pound, ounce, and grain of this weight are the same as those of Troy weight; the pound in each contains 12 oz. = 5760 gr.

Avoirdupois or Commercial Weight.

189. Avoirdupois or **Commercial Weight** is used for weighing all ordinary articles.

TABLE.

16	ounces,	marked oz.,	make 1	pound,	marked lb.
25	lb.	"	1	quarter,	" qr.
4	qr.	"	1	hundred-weight,	" cwt.
20	cwt.	"	1	ton,	" T.

EQUIVALENT TABLE.

T.	cwt.	qr.	lb.	oz.
1 =	20 =	80 =	2000 =	32000.
	1 =	4 =	100 =	1600.
		1 =	25 =	400.
			1 =	16.

REMARKS.—1. In Great Britain, the qr. = 28 lb., the cwt. = 112 lb., the ton = 2240 lb. These values are used at the United States custom-houses in invoices of English goods, and are still used in some lines of trade, such as coal and iron.

2. Among other weights sometimes mentioned in books, are: 1 stone, horseman's weight, = 14 lb.; 1 stone of butcher's meat = 8 lb.; 1 clove of wool = 7 lb.

3. The lb. avoirdupois is equal to the weight of 27.7274 cu. in. of distilled water at 62° (Fahr.); or 27.7015 cu. in. at its maximum density, the barometer at 30 inches. For ordinary purposes, 1 cubic foot of water can be taken $62\frac{1}{4}$ lb. avoirdupois.

4. The terms *gross* and *net* are used in this weight. *Gross weight* is the weight of the goods, together with the box, cask, or whatever contains them. *Net weight* is the weight of the goods alone.

5. The word *avoirdupois* is from the French *avoirs, du, pois*, signifying *goods of weight.*

6. The ounce is often divided into halves and quarters in weighing. The sixteenth of an ounce is called a *dram.*

COMPARISON OF WEIGHTS.

190. The pound Avoirdupois weighs 7,000 grains Troy, and the Troy pound weighs 5,760 grains, hence there are 1,240 grains more in the Avoirdupois pound than in the Troy pound.

The following table exhibits the relation between certain denominations of Avoirdupois, Troy, and Apothecaries' Weight.

Avoirdupois.		Troy.		Apothecaries'.
1 lb.	=	$1\frac{31}{144}$ ℔.	=	$1\frac{31}{144}$ ℔.
1 oz.	=	$\frac{175}{192}$ oz.	=	$\frac{175}{192}$ ℥.
		1 ℔.	=	1 ℔.
		1 oz.	=	1 ℥.
		1 gr.	=	1 gr.
		1 pwt.	=	$\frac{2}{5}$ ʒ.
		1 pwt.	=	$1\frac{1}{5}$ ℈.

REMARK.—In addition to the foregoing, the following, called *Diamond Weight*, is used in weighing diamonds and other precious stones.

TABLE.

16 parts	make 1 carat grain	= .792 Troy grains.
4 carat grains	" 1 carat	= 3.168 " "

NOTE.—This carat is entirely different from the *assay carat*, which has reference to the *fineness* of gold. The mass of gold is considered as divided into twenty-four parts, called carats, and is said to be so many carats fine, according to the number of twenty-fourths of pure gold which it contains.

MEASURES OF EXTENSION.

191. 1. **Extension** is that property of matter by which it occupies space. It may have one or more of the three dimensions,—length, breadth, and thickness.

2. A **line** has only one dimension,—length.

3. A **surface** has two dimensions, length and breadth.

4. A **solid** or **volume** has three dimensions,—length, breadth, and thickness.

192. **Measures of Extension** embrace:

1. Linear Measure. { Long Measure. / Chain Measure. / Mariners' Measure. / Cloth Measure.
2. Superficial Measure. { Square Measure. / Surveyors' Measure.
3. Solid Measure.
4. Measures of Capacity. { Liquid Measure. / Apothecaries' Measure. / Dry Measure.
5. Angular Measure.

Long or Linear Measure.

193. Linear Measure is used in measuring distances, or length, in any direction.

The standard unit for all measures of extension is the **yard,** which is identical with the Imperial yard of Great Britain.

TABLE.

12	inches,	marked	in.,	make 1 foot,	marked ft.
3	ft.		"	1 yard, "	yd.
$5\frac{1}{2}$	yd. or $16\frac{1}{2}$ ft.		"	1 rod, "	rd.
320	rd.		"	1 mile, "	mi.

EQUIVALENT TABLE.

mi.	rd.	yd.	ft.	in.
1 =	320 =	1760 =	5280 =	63360.
	1 =	$5\frac{1}{2}$ =	$16\frac{1}{2}$ =	198.
		1 =	3 =	36.
			1 =	12.

REMARKS.—1. The *standard yard* of the United States was obtained from England in 1856. It is of bronze, and of due length at 59.8° Fahr. A copy of the former standard is deposited at each state capital: this was about $\frac{1}{1000}$ of an inch too long.

2. The *rod* is sometimes called *perch* or *pole.* The *furlong,* equal to 40 rods, is seldom used.

3. The *inch* may be divided into halves, fourths, eighths, etc., or into tenths, hundredths, etc.

4. The following measures are sometimes used:

12 lines	make	1 inch.
3 barleycorns	"	1 "
3 inches	"	1 palm.
4 inches	"	1 hand.
9 inches	"	1 span.
18 inches	"	1 cubit.
3 feet	"	1 pace.

194. Chain Measure is used by surveyors in measuring land, laying out roads, establishing boundaries, etc.

TABLE.

7.92	inches,	marked	in.,	make 1	link, marked li.
100	li.		"	1	chain, " ch.
80	ch.		"	1	mile, " mi.

EQUIVALENT TABLE.

mi.	ch.	li.	in.
1	= 80	= 8000	= 63360.
	1	= 100	= 792.
		1	= 7.92.

REMARKS.—1. The surveyors' chain, or Gunter's chain, is 4 rods, or 66 feet in length. Since it consists of 100 links, the chains and links may be written as integers and hundredths; thus, 2 chains 56 links are written 2.56 ch.

2. The engineers' chain is 100 feet long, and consists of 100 links.

3. The engineers' leveling rod is used for measuring *vertical* distances. It is divided into feet, tenths, and hundredths, and, by means of a vernier, may be read to thousandths.

195. Mariners' Measure is used in measuring the depth of the sea, and also distances on its surface.

TABLE.

6	feet	make 1	fathom.
720	feet	" 1	cable-length.

REMARKS.—1. A nautical mile is one minute of longitude, measured on the equator at the level of the sea. It is equal to $1.152\frac{2}{3}$ statute miles. 60 nautical miles = 1 degree on the equator, or 69.16 statute miles. A league is equal to 3 nautical miles, or 3.458 statute miles.

2. Depths at sea are measured in fathoms; distances are usually measured in nautical miles.

196. Cloth Measure is used in measuring dry-goods. The standard yard is the same as in Linear Measure, but is divided into *halves*, *quarters*, *eighths*, *sixteenths*, etc., in place of feet and inches.

REMARKS.—1. There was formerly a recognized table for Cloth Measure, but it is now obsolete. The denominations were as follows:

2¼	inches, marked	in.,	make 1 nail,	marked na.
4	na. or 9 in.	"	1 quarter, "	qr.
4	qr.	"	1 yard, "	yd.

2. At the custom-house, the yard is divided decimally.

Superficial or Surface Measure.

197. 1. **Superficial Measure** is used in estimating the numerical value of surfaces; such as, land, weather-boarding, plastering, paving, etc.

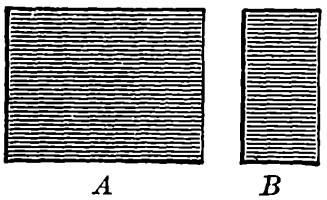
2. A **surface** has length and breadth, but not thickness.

3. The **area** of a surface is its numerical value; or the number of times it contains the *measuring unit.*

4. A **superficial unit** is an assumed unit of measure for surfaces.

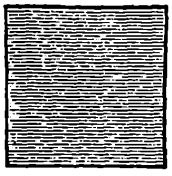
Usually the square, whose side is the linear unit, is the **unit of measure;** as, the *square inch*, *square foot*, *square yard.*

5. A **Rectangle** may be defined as a surface bounded by four straight lines forming four square corners; as either of the figures A, B.



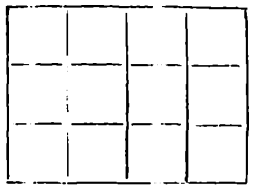
A *B*

6. When the four sides are equal the rectangle is called a **square;** as the figure C.



C

7. *The area of a rectangle is equal to its length multiplied by its breadth.*



EXPLANATION.—Take a rectangle 4 inches long by 3 inches wide. If upon each of the inches in the length, a square inch be conceived to stand, there will be a row of 4 square inches, extending the whole length of the rectangle, and reaching 1 inch of its width. As the rectangle contains as many such rows as there are inches in its width, its area must be equal to the number of square inches in a row (4) multiplied by the number of rows (3), = 12 square inches. This statement (7), as commonly understood, can present no exception to Prin. 2, Art. 60.

TABLE.

144 square inches (sq. in.) make 1 square foot, marked sq. ft.
9 sq. ft. " 1 square yard, " sq. yd.
$30\frac{1}{4}$ sq. yd. " 1 square rod, " sq. rd.
160 sq. rd. " 1 acre, " A.

EQUIVALENT TABLE.

A.	sq. rd.	sq. yd.	sq. ft.	sq. in.
1 =	160 =	4840 =	43560 =	6272640.
	1 =	$30\frac{1}{4}$ =	$272\frac{1}{4}$ =	39204.
		1 =	9 =	1296.
			1 =	144.

NOTE.—The following, though now seldom used, are often found in records of calculations:

40 perches (P.), or sq. rds., make 1 rood, marked R.
4 roods " 1 acre, " A.

198. Surveyors' Measure is a kind of superficial measure, which is used chiefly in *government* surveys.

TABLE.

625 square links (sq. li.) make 1 square rod, sq. rd.
16 sq. rd. " 1 square chain, sq. ch.
10 sq. ch. " 1 acre, A.
640 A. " 1 square mile, sq. mi.
36 sq. mi. (6 miles square) " 1 township, Tp.

EQUIVALENT TABLE.

Tp.	sq. mi.	A.	sq. ch.	sq. rd.	sq. li.
1 =	36 =	23040 =	230400 =	3686400 =	2304000000.
	1 =	640 =	6400 =	102400 =	64000000.
		1 =	10 =	160 =	100000.
			1 =	16 =	10000.
				1 =	625.

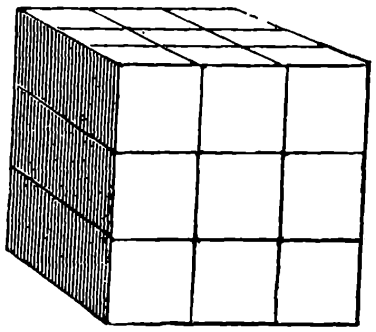
Solid Measure.

199. A **Solid** has length, breadth, and thickness.

Solid Measure is used in estimating the *contents* or *volume* of solids.

A **Cube** is a solid, bounded by six equal squares, called *faces*. Its length, breadth, and thickness are all equal.

REMARK.—The size or name of any cube, like that of a square, depends upon its side, as cubic inch, cubic foot, cubic yard.



EXPLANATION.—If each side of a cube is 1 inch long, it is called a cubic inch; if each side is 3 feet (1 yard) long, as represented in the figure, it is a cubic or solid yard.

When the base of a cube is 1 square yard, it contains $3 \times 3 = 9$ square feet; and 1 foot high on this base, contains 9 solid feet; 2 feet high contains $9 \times 2 = 18$ solid feet; 3 feet high contains $9 \times 3 = 27$ solid feet. Also it may be shown that 1 solid or *cubic* foot contains $12 \times 12 \times 12 = 1728$ solid or *cubic* inches.

The unit by which all solids are measured is a cube, whose side is a linear inch, foot, etc., and their size or solidity will be the number of times they contain this unit.

REMARK.—The simplest solid is the *rectangular* solid, which is bounded by six rectangles, called its *faces*, each opposite pair being equal, and perpendicular to the other four; as, for example, the

ordinary form of a brick or a box of soap. If the length, breadth, and thickness are the same, the faces are squares, and the solid is a cube.

TABLE.

1728 cubic inches (cu. in.) make 1 cubic foot, cu. ft.
27 cu. ft. " 1 cubic yard, cu. yd.

EQUIVALENT TABLE.

cu. yd.	cu. ft.	cu. in.
1	= 27	= 46656.
	1	= 1728.

REMARKS.—1. A *perch* of stone is a mass $16\frac{1}{2}$ ft. long, $1\frac{1}{2}$ ft. wide, and 1 ft. high, and contains $24\frac{3}{4}$ cu. ft.

2. Earth, rock-excavations, and embankments are estimated by the cubic yard.

3. Round timber will lose $\frac{1}{5}$ in being sawed, hence 50 cubic ft. of round timber is said to be equal to 40 cubic ft. of hewn timber, which is a *ton.*

4. Fire-wood is usually measured by the *cord.* A pile of wood 4 ft. high, 4 ft. wide, and 8 ft. long, contains 128 cubic feet or one cord. One foot in length of this pile, or 16 cu. ft., is called a *cord foot.*

5. Planks and scantling are estimated by *board measure.* In this measure, 1 *reduced foot,* 1 ft. long, 1 ft. wide, and 1 in. thick, contains $12 \times 12 \times 1 = 144$ cu. in. All planks and scantling less than an inch thick, are reckoned at that thickness; but, if more than an inch thick, allowance must be made for the excess.

Measures of Capacity.

200. Capacity means *room* for things.

Measures of Capacity are divided into *Measures of Liquids* and *Measures of Dry Substances.*

201. Liquid Measure is used in measuring liquids, and in estimating the capacities of cisterns, reservoirs, etc.

The **gallon,** which contains 231 cu. in., is the unit of measure in liquids.

NOTE.—This gallon of 231 cubic inches was the standard in England at the time of Queen Anne. The present *imperial gallon* of England contains 10 lb. of water at 62° Fahr., or 277.274 cubic inches.

TABLE.

4 gills,	marked gi.,	make	1 pint,	marked	pt.
2 pt.		"	1 quart,	"	qt.
4 qt.		"	1 gallon,	"	gal.

EQUIVALENT TABLE.

gal.	qt.	pt.	gi.
1	= 4	= 8	= 32.
	1	= 2	= 8.
		1	= 4.

NOTE.—Sometimes the barrel is estimated at 31½ gal., and the hogshead at 63 gal.; but usually each package of this description is gauged separately.

202. Apothecaries' Fluid Measure is used for measuring all liquids that enter into the composition of medical prescriptions.

TABLE.

60 minims,	marked ♏.,	make	1 fluid drachm,	marked	f℥.
8 f℥		"	1 fluid ounce,	"	f℥.
16 f℥		'	1 pint,	"	O.
8 O		"	1 gallon,	"	cong.

EQUIVALENT TABLE.

cong.	O.	f℥.	f℥.	♏.
1	= 8	= 128	= 1024	= 61440.
	1	= 16	= 128	= 7680.
		1	= 8	= 480.
			1	= 60.

NOTES.—1. Cong. is an abbreviation for *congiarium*, the Latin for gallon; O. is the initial of *octans*, the Latin for *one eighth*, the pint being one eighth of a gallon.

2. For ordinary purposes, 1 tea-cup = 2 wine-glasses = 8 table-spoons = 32 tea-spoons = 4 f℥.

203. Dry Measure is used for measuring grain, fruit, vegetables, coal, salt, etc.

The **Winchester bushel** is the unit; it was formerly used in England, and so called from the town where the standard was kept. It is 8 in. deep, and $18\frac{1}{2}$ in. in diameter, and contains 2150.42 cu. in., or 77.6274 lb. av. of distilled water at maximum density, the barometer at 30 inches.

NOTE.—This bushel was discarded by Great Britain in 1826, and the *imperial bushel* substituted; the latter contains 2218.192 cu. in., or eighty pounds avoirdupois of distilled water.

TABLE.

2 pints,	marked	pt.,	make 1 quart,	marked	qt.
8 qt.			" 1 peck,	"	pk.
4 pk.			" 1 bushel,	"	bu.

EQUIVALENT TABLE.

bu.	pk.	qt.	pt.
1	= 4	= 32	= 64.
	1	= 8	= 16.
		1	= 2.

REMARKS.—1. 4 qt. or $\frac{1}{2}$ peck = 1 dry gal. = 268.8 cu. in. nearly.

2. The *quarter* is still used in England for measuring *wheat*, of which it holds eight bushels, or 480 pounds avoirdupois.

3. When articles usually measured by the above table are sold by weight, the *bushel* is taken as the unit. The following table gives the legal weight of a bushel of various articles in avoirdupois pounds:

TABLE.

ARTICLES.	LB.	EXCEPTIONS.
Beans.	60	Me., 64; N. Y., 62.
Coal.	80	Ohio, 70 of cannel; Ind., 70 mined out of the state; Ky., 76 of anthracite.
Corn (Indian).	56	N. Y., 58; Cal., 52; Arizona, 54.
Flax Seed.	56	N. Y. and N. J., 55; Kan., 54.
Oats.	32	Md., 26; Me., N. H., N. J., Pa., 30; Neb., 34; Montana, 35; Oregon and Wash., 36.
Potatoes (Irish).	60	Ohio, 58; Wash., 50.
Rye.	56	La., 32; Cal., 54.
Salt.	50	Mass., 70; Pa., coarse, 85; ground, 70; fine, 62; Ky. and Ill., fine, 55; Mich., 56; Col. and Dak., 80.
Wheat.	60	

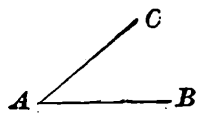
COMPARATIVE TABLE OF MEASURES.

	cu. in. gal.	cu. in. qt.	cu. in. pt.	cu. in. gi.
Liquid Measure,	231	$57\frac{3}{4}$	$28\frac{7}{8}$	$7\frac{7}{32}$
Dry Measure ($\frac{1}{2}$ pk.),	$268\frac{4}{5}$	$67\frac{1}{5}$	$33\frac{3}{5}$	$8\frac{2}{5}$

Angular or Circular Measure.

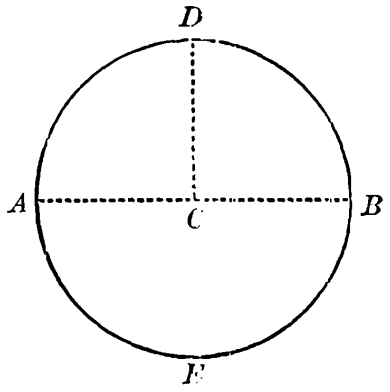
204. A **plane angle** is the difference of direction of two straight lines which meet at a point.

EXPLANATION.—Thus, the two lines AB and AC meet at the point A, called the *apex*. The lines AB and AC are the *sides* of the angle, and the difference in direction, or the *opening* of the lines, is the *angle itself*.



Angular Measure is used to measure angles, directions, latitude, and longitude, in navigation, astronomy, etc.

A **circle** is a plane surface bounded by a line, all the points of which are equally distant from a point within.



EXPLANATIONS.—The bounding line ADBEA is a *circumference.* Every point of this line is at the same distance from the point C, which is called the *center.* The *circle* is the area included within the circumference. Any straight line drawn from the center to the circumference is called a *radius;* thus, CD and CB are radii. Any part of the circumference, as AEB or AD, is an *arc.* A straight line, like AB, drawn through the center, and having its ends in the circumference, is a *diameter;* it divides the circle into two equal parts.

NOTES.—1. Every circumference contains 360 degrees; and, the apex of an angle being taken as the center of a circle, the angle is measured by the number of degrees in the arc included by the sides of the angle.

2. The angle formed by two lines perpendicular to each other, as the radii AC and DC in the above figure, is a *right angle,* and is measured by the fourth part of a circumference, 90°, called a *quadrant.*

TABLE.

60 seconds,	marked ″,	make 1 minute,	marked,	′.
60′		" 1 degree,	"	°.
360°		" 1 circumference,	"	c.

EQUIVALENT TABLE.

c.	°	′	″
1 =	360 =	21600 =	1296000.
	1 =	60 =	3600.
		1 =	60.

NOTE.—The twelfth part of a circumference, or 30°, is called a *sign.*

MEASURE OF TIME.

205. 1. **Time** is a measured portion of duration.

2. A **Year** is the time of the revolution of the earth

around the sun; a **Day** is the time of the revolution of the earth on its axis.

3. The **Solar Day** is the interval of time between two successive passages of the sun over the same meridian.

4. The **Mean Solar Day** is the mean, or average, length of all the solar days in the year. Its duration is 24 hours, and it is the unit of Time Measure.

5. The **Civil Day,** used for ordinary purposes, commences at midnight and closes at the next midnight.

6. The **Astronomical Day** commences at noon and closes at the next noon.

TABLE.

60	seconds, marked sec.,	make	1	minute, marked	min.
60	min.	"	1	hour, "	hr.
24	hr.	"	1	day, "	da.
7	da.	"	1	week, "	wk.
4	wk.	"	1	month, "	mon.
12	calendar mon.	"	1	year, "	yr.
365	da.	"	1	common year.	
366	da.	"	1	leap year.	
100	yr.	"	1	century, marked	cen.

NOTE.—1 Solar year = 365 da. 5 hr. 48 min. 46.05 sec. = $365\frac{1}{4}$ da., nearly.

EQUIVALENT TABLE.

yr.	mo.	wk.	da.	hr.	min.	sec.
1 =	12 =	52 =	365 =	8760 =	525600 =	31536000.
			366 =	8784 =	527040 =	31622400.
		1 =	7 =	168 =	10080 =	604800.
			1 =	24 =	1440 =	86400.
				1 =	60 =	3600.
					1 =	60.

NOTE.—The ancients were unable to find accurately the number of days in a year. They had 10, afterward 12, calendar months, corresponding to the revolutions of the moon around the earth. In the time of Julius Cæsar the year contained 365¼ days; instead of taking account of the ¼ of a day every year, the common or civil year was reckoned 365 days, and every 4th year a day was inserted (called the *intercalary* day), making the year then have 366 days. The extra day was introduced by repeating the 24th of February, which, with the Romans, was called the *sixth day before the kalends of March*. The years containing this day twice, were on this account called *bissextile*, which means *having two sixths*. By us they are generally called *leap* years.

But 365¼ days (365 days and 6 hours) are a little longer than the true year, which is 365 days 5 hours 48 minutes 46.05 seconds. The difference, 11 minutes 13.95 seconds, though small, produced, in a long course of years, a sensible error, which was corrected by Gregory XIII., who, in 1582, suppressed the 10 days that had been gained, by decreeing that the 5th of October should be the 15th.

206. To prevent difficulty in future, it has been decided to adopt the following rule.

Rule for Leap Years.—*Every year that is divisible by* 4 *is a leap year, unless it ends with two ciphers; in which case it must be divisible by* 400 *to be a leap year.*

ILLUSTRATION.—Thus, 1832, 1648, 1600, and 2000 are leap years; but 1857, 1700, 1800, 1918, are not.

NOTES.—1. The *Gregorian* calendar was adopted in England in 1752. The error then being 11 days, Parliament declared the 3d of September to be the 14th, and at the same time made the year begin January 1st, instead of March 25th. Russia, and all other countries of the Greek Church, still use the Julian calendar; consequently their dates (*Old Style*) are now 12 days later than ours (*New Style*). The error in the Gregorian calendar is small, amounting to a day in 3600 years.

2. The year formerly began with March instead of January; consequently, September, October, November, and December were the 7th, 8th, 9th, and 10th months, as their names indicate; being derived from the Latin numerals Septem (7), Octo (8), Novem (9), Decem (10).

COMPARISON OF TIME AND LONGITUDE.

207. The **longitude** of a place is its distance in degrees, minutes, and seconds, east or west of an established meridian.

NOTE.—The *difference of longitude* of two places on the same side of the established meridian, is found by subtracting the less longitude from the greater; but, of two places on opposite sides of the meridian, the difference of longitude is found by adding the longitude of one to the longitude of the other.

The circumference of the earth, like other circles, is divided into 360 equal parts, called *degrees of longitude.*

The sun appears to pass entirely round the earth, 360°, once in 24 hours, *one day;* and in 1 hour it passes over 15°. (360° ÷ 24 = 15°.)

As 15° equal 900′, and 1 hour equals 60 minutes of *time*, therefore, the sun in 1 minute of *time* passes over 15′ of a *degree.* (900′ ÷ 60 = 15′.)

As 15′ equal 900″, and 1 minute of *time* equals 60 seconds of *time*, therefore, in 1 second of *time* the sum passes over 15″ of a *degree.* (900″ ÷ 60 = 15″.)

TABLE FOR COMPARING LONGITUDE AND TIME.

15° of longitude = 1 hour of time.
15′ of longitude = 1 min. of time.
15″ of longitude = 1 sec. of time.

NOTE.—If one place has greater east or less west longitude than another, its time must be later; and, conversely, if one place has later time than another, it must have greater east or less west longitude.

MISCELLANEOUS TABLES.

208. The words folio, quarto, octavo, etc., used in speaking of books, show how many leaves a sheet of paper makes.

A sheet folded into

2	leaves,	called a	folio,	makes	4	pages.
4	"	" a	quarto or 4to,	"	8	"
8	"	" an	octavo or 8vo,	"	16	"
12	"	" a	duodecimo or 12mo,	"	24	"
16	"	" a	16mo,	"	32	"
32	"	" a	32mo,	"	64	"

Also,	24 sheets of paper	make	1 quire.
	20 quires	"	1 ream.
	2 reams	"	1 bundle.
	5 bundles	"	1 bale.

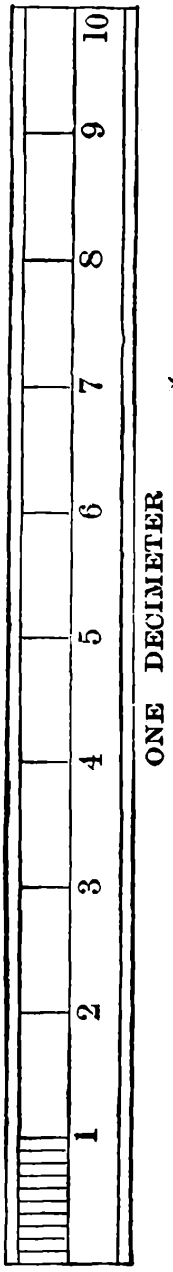
12	things	make	1 dozen.
12	dozens or 144 things	"	1 gross.
12	gross or 144 dozens	"	1 great gross.
20	things	"	1 score.
56	lb.	"	1 firkin of butter.
100	lb.	"	1 quintal of fish.
196	lb.	"	1 bbl. of flour.
200	lb.	"	1 bbl. of pork.

THE METRIC SYSTEM.

Historical.

The Metric System is an outgrowth of the French Revolution of 1789. At that time there was a general disposition to break away from old customs; and the revolutionists contended that every thing needed remodeling. A commission was appointed to determine an invariable standard for all measures of length, area, solidity, capacity, and weight. After due deliberation, an accurate survey was made of that portion of the terrestrial meridian through Paris, between Dunkirk, France, and Barcelona, Spain; and from this, the distance on that meridian from the equator to the pole was computed. The quadrant thus obtained was divided into ten million equal parts; one part was called a *meter*, and is the *base* of the system. From it all measures are derived.

In 1795 the Metric System was adopted in France. It is now used in nearly all civilized countries. It was authorized by an act of Congress in the United States in 1866.



209. The **Metric System** is a decimal system of weights and measures.

The **meter** is the primary unit upon which the system is based, and is also the unit of length. It is 39.37043 inches long, which is very nearly one ten-millionth part of the distance on the earth's surface from the equator to the pole, as measured on the meridian through Paris.

REMARK.—The *standard meter*, a bar of platinum, is kept among the archives in Paris. Duplicates of this bar have been furnished to the United States.

210. The **names** of the *lower* denominations in each measure of the Metric System are formed by prefixing the *Latin* numerals, *deci* (.1), *centi* (.01), and *milli* (.001) to the *unit* of that measure; those of the *higher* denominations, by prefixing the *Greek* numerals, *deka* (10), *hekto* (100), *kilo* (1000), and *myria* (10000), to the same unit.

These prefixes may be grouped about the unit of measure, showing the decimal arrangement of the system, as follows:

Lower Denominations.	milli	=	.001
	centi	=	.01
	deci	=	.1
Unit of Measure		=	1.
Higher Denominations.	deka	=	10.
	hekto	=	100.
	kilo	=	1000.
	myria	=	10000.

211. The **units** of the various measures, to which these prefixes are attached, are as follows:

The Meter, which is the unit of Length.
The Ar, " " " " " Surface.
The Liter, " " " " " Capacity.
The Gram, " " " " " Weight.

REMARK.—The name of each denomination thus derived, immediately shows its relation to the unit of measure. Thus, a *centimeter* is one one-hundredth of a meter; a *kilogram* is a thousand grams; a *hektoliter* is one hundred liters, etc.

Measure of Length.

212. The **Meter** is the unit of Length, and is the denomination used in all ordinary measurements.

TABLE.

10 millimeters, marked mm.,	make	1 centimeter,	marked	cm.
10 centimeters	"	1 decimeter,	"	dm.
10 decimeters	"	1 **meter,**	"	m.
10 meters	"	1 dekameter,	"	Dm.
10 dekameters	"	1 hektometer,	"	Hm.
10 hektometers	"	1 kilometer,	"	Km.
10 kilometers	"	1 myriameter,	"	Mm.

REMARKS.—1. The figure on page 148 shows the exact length of the decimeter, and its subdivisions the centimeter and millimeter.

2. The centimeter and millimeter are most often used in measuring very short distances; and the kilometer, in measuring roads and long distances.

Measure of Surface.

213. The **Ar** (*pro.* är) is the unit of Land Measure; it is a square, each side of which is 10 meters (1 dekameter) in length, and hence its area is one square dekameter.

TABLE.

100 centars,	marked ca.,	make 1	**ar,**	marked a.
100 ars		" 1	hektar, "	Ha.

REMARK.—The *square meter* (marked m^2) and its subdivisions are used for measuring small surfaces.

Measure of Capacity.

214. The **Liter** (*pro.* lē′ter) is the unit of Capacity. It is equal in volume to a cube whose edge is a decimeter; that is, one tenth of a meter.

TABLE.

10 milliliters,	marked ml.,	make 1	centiliter,	marked cl.
10 centiliters	"	1	deciliter, "	dl.
10 deciliters	"	1	**liter,** "	l.
10 liters	"	1	dekaliter, "	Dl.
10 dekaliters	"	1	hektoliter, "	Hl.

REMARKS.—1. This measure is used for liquids and for dry substances. The denominations most used are the liter and hektoliter; the former in measuring milk, wine, etc., in moderate quantities, and the latter in measuring grain, fruit, etc., in large quantities.

2. Instead of the milliliter and the kiloliter, it is customary to use the cubic centimeter and the cubic meter (marked m^3), which are their equivalents.

3. For measuring wood the *ster* (pro. stêr) is used. It is a cubic meter in volume.

Measure of Weight.

215. The **Gram** (*pro.* grăm) is the unit of Weight. It was determined by the weight of a cubic centimeter of distilled water, at the temperature of melting ice.

TABLE.

10 milligrams,	marked	mg.,	make 1 centigram,	marked	cg.
10 centigrams		"	1 decigram,	"	dg.
10 decigrams		"	1 **gram,**	"	g.
10 grams		"	1 dekagram,	"	Dg.
10 dekagrams		"	1 hektogram,	"	Hg.
10 hektograms		"	1 kilogram,	"	Kg.
10 kilograms		"	1 myriagram,	"	Mg.
10 myriagrams, or 100 kilograms		"	1 quintal,	"	Q.
10 quintals, or 1000	"	"	1 metric ton,	"	M.T.

REMARKS.—1. The gram, kilogram (*pro.* kĭl′o-gram), and metric ton are the weights commonly used.

2. The gram is used in all cases where great exactness is required; such as, mixing medicines, weighing the precious metals, jewels, letters, etc.

3. The kilogram, or, as it is commonly abbreviated, the "kilo," is used in weighing coarse articles, such as groceries, etc.

4. The metric ton is used in weighing hay and heavy articles generally.

216. Since, in the Metric System, 10, 100, 1000, etc., units of a lower denomination make a unit of the higher denomination, the following principles are derived:

PRINCIPLES.—1. *A number is reduced to a* LOWER *denomination by removing the decimal point as many places to the* RIGHT *as there are ciphers in the multiplier.*

2. *A number is reduced to a* HIGHER *denomination by removing the decimal point as many places to the* LEFT *as there are ciphers in the divisor.*

ILLUSTRATIONS.—Thus, 15.03 m. is read 15 meters and 3 centimeters; or, 15 and 3 hundredths meters. Again, 15.03 meters = 1.503 dekameters = .1503 hektometer = 150.3 decimeters = 1503 centimeters. As will be seen, the reduction is effected by changing the decimal point in precisely the same manner as in United States Money.

217. The following table presents the legal and approximate values of those denominations of the Metric System which are in common use.

TABLE.

DENOMINATION.	LEGAL VALUE.	APPROX. VALUE.
Meter.	39.37 inches.	3 ft. $3\frac{3}{8}$ inches.
Centimeter.	.3937 inch.	$\frac{2}{5}$ inch.
Millimeter.	.03937 inch.	$\frac{1}{25}$ inch.
Kilometer.	.62137 mile.	$\frac{5}{8}$ mile.
Ar.	119.6 sq. yards.	4 sq. rods.
Hektar.	2.471 acres.	$2\frac{1}{2}$ acres.
Square Meter.	1.196 sq. yards.	$10\frac{3}{4}$ sq. feet.
Liter.	1.0567 quarts.	1 quart.
Hektoliter.	2.8375 bushels.	2 bu. $3\frac{1}{3}$ pecks.
Cubic Centimeter.	.061 cu. inch.	$\frac{1}{16}$ cu. inch.
Cubic Meter.	1.308 cu. yards.	$35\frac{1}{3}$ cu. feet.
Ster.	.2759 cord.	$\frac{1}{4}$ cord.
Gram.	15.432 grains troy.	$15\frac{1}{2}$ grains.
Kilogram.	2.2046 pounds av.	$2\frac{1}{5}$ pounds.
Metric Ton.	2204.6 pounds av.	1 T. 204 pounds.

Topical Outline.

COMPOUND NUMBERS.

1. Preliminary Definitions.
2. Value.....
   1. Definitions.
   2. United States and Canadian Money.
   3. English Money.
   4. French Money.
   5. German Money.
3. Weight.....
   1. Troy Weight.
   2. Apothecaries' Weight.
   3. Avoirdupois Weight.

COMPOUND NUMBERS.—(*Concluded.*)

- 4. Extension.
  - 1. Linear...
    - 1. Long Measure.
    - 2. Chain Measure.
    - 3. Mariners' Measure.
    - 4. Cloth Measure.
  - 2. Superficial Measure....
    - 1. Surface Measure.
    - 2. Surveyors' Measure.
  - 3. Solid Measure.
  - 4. Measures of Capacity.
    - 1. Liquid.
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  - 5. Angular Measure.
- 5. Time.
- 6. Comparison of Time and Longitude.
- 7. Miscellaneous Tables.
- 8. Metric System.
  - 1. Historical.
  - 2. Terms....
    - 1. How Derived.
    - 2. Lower Denominations...
      - 1. Milli.
      - 2. Centi.
      - 3. Deci.
    - 3. Higher Denominations..
      - 1. Deka.
      - 2. Hekto.
      - 3. Kilo.
      - 4. Myria.
  - 3. Units.....
    - 1. Meter.
    - 2. Ar.
    - 3. Liter.
    - 4. Gram.
  - 4. Measures...
    - 1. Length.
    - 2. Surface.
    - 3. Capacity.
    - 4. Weight.
  - 5. Principles.
  - 6. Table of Legal and Approximate Values.

REDUCTION OF COMPOUND NUMBERS.

218. Reduction of Compound Numbers is the process of changing them to equivalent numbers of a different denomination.

Reduction takes place in two ways:

From a higher denomination to a lower.

From a lower denomination to a higher.

PRINCIPLES.—1. *Reduction from a higher denomination to a lower, is performed by multiplication.*

2. *Reduction from a lower denomination to a higher, is performed by division.*

PROBLEM.—Reduce 18 bushels to pints.

SOLUTION.—Since 1 bu. = 4 pk., 18 bu. = 18 times 4 pk. = 72 pk., and since 1 pk. = 8 qt., 72 pk. = 72 times 8 qt. = 576 qt.; and since 1 qt. = 2 pt., 576 qt. = 576 times 2 pt. = 1152 pt. Or, since 1 bu. = 64 pt., multiply 64 pt. by 18, which gives 1152 pt. as before. This is sometimes called *Reduction Descending.*

OPERATION.

18 bu.
4
72 pk.
8
576 qt.
2
1152 pt.

18 bu. = 1152 pt.

PROBLEM.—Reduce 236 inches to yards.

SOLUTION.—Since 12 inches = 1 ft., 236 inches will be as many feet as 12 in. is contained times in 236 in., which is $19\frac{2}{3}$ ft., and since 3 ft. = 1 yd., $19\frac{2}{3}$ ft will be as many yd. as 3 ft. is contained times in $19\frac{2}{3}$ ft., which is $6\frac{5}{9}$ yd. Or, since 1 yd. = 36 in., divide 236 in. by 36 in., which gives $6\frac{5}{9}$ yd., as before. This is sometimes called *Reduction Ascending.*

OPERATION.

12)236 in.
3) $19\frac{2}{3}$ ft.
$6\frac{5}{9}$ yd.

236 in. = $6\frac{5}{9}$ yd.

NOTE.—In the last example, instead of dividing 236 in. by 36 in. the unit of value of yards, since 1 inch is equal to $\frac{1}{36}$ yards, 236 inches = $236 \times \frac{1}{36} = \frac{236}{36}$ yd. = $6\frac{5}{9}$ yd. The operation by division is generally more convenient.

REMARK.—Reduction Descending diminishes the *size*, and, therefore, increases the *number* of units given; while Reduction Ascending increases the *size*, and, therefore, diminishes the *number* of units given. This is further evident from the fact, that the multipliers in Reduction Descending are *larger* than 1; but in Reduction Ascending *smaller* than 1.

PROBLEM.—Reduce $\frac{3}{8}$ gallons to pints.

SOLUTION.—Multiply by 4 to reduce gal. to qt.; then by 2 to reduce qt. to pt. Indicate the operation, and cancel.

OPERATION.

$$\frac{3}{\cancel{8}} \times \cancel{4} \times \cancel{2} = 3 \text{ pt.}$$

$\frac{3}{8}$ gal. = 3 pt.

PROBLEM.—Reduce $5\frac{5}{7}$ gr. to ℨ.

SOLUTION. — Although this is Reduction Ascending, we use Prin. 1, in multiplying by the successive unit values, $\frac{1}{20}$, $\frac{1}{3}$, and $\frac{1}{8}$.

OPERATION.

$$5\tfrac{5}{7} \text{ gr.} = \frac{\cancel{2}}{\cancel{40}}{7} \times \frac{1}{\cancel{2}\cancel{0}} \times \frac{1}{3} \times \frac{1}{\cancel{8}_{4}} = \frac{1}{84} \text{ ℨ.}$$

$5\frac{5}{7}$ gr. = $\frac{1}{84}$ ℨ.

PROBLEM.—Reduce 9.375 acres to square rods.

OPERATION.

$$\begin{array}{r} 9.375 \\ 160 \\ \hline 562500 \\ 9375 \\ \hline 1500.000 \text{ sq. rd.} \end{array}$$

9.375 A. = 1500 sq. rd.

PROBLEM.—Reduce 2000 seconds to hours.

OPERATION.

$$2000 \times \frac{1}{60} \times \frac{1}{60} = \frac{20}{36} = \frac{5}{9} \text{ hr.}$$

2000 sec. = $\frac{5}{9}$ hr.

PROBLEM.—Reduce 1238.73 hektograms to grams.

OPERATION.

$$1238.73 \times 100 = 123873 \text{ grams.}$$

PROBLEM.—How many yards in 880 meters?

OPERATION.

$$\frac{39.37 \text{ in.} \times 880}{12 \times 3} = 962.377 + \text{yd.}$$

REMARK.—Abstract factors can not produce a concrete result; *sometimes*, however, in the steps of an indicated solution, where the change of denomination is *very* obvious, the abbreviations may be omitted until the result is written.

From the preceding exercises, the following rules are derived:

219. For reducing from higher to lower denominations.

Rule.—1. *Multiply the highest denomination given, by that number of the next lower which makes a unit of the higher.*

2. *Add to the product the number, if any, of the lower denomination.*

3. *Proceed in like manner with the result thus obtained, till the whole is reduced to the required denomination.*

220. For reducing from lower to higher denominations.

Rule.—1. *Divide the given quantity by that number of its own denomination which makes a unit of the next higher.*

2. *Proceed in like manner with the quotient thus obtained, till the whole is reduced to the required denomination.*

3. *The last quotient, with the several remainders, if any, annexed, will be the answer.*

NOTE.—In the Metric System the operations are performed by removing the point to the right or to the left.

Examples for Practice.

1. How many square rods in a rectangular field 18.22 chains long by 4.76 ch. wide?
2. Reduce 16.02 chains to miles.
3. How many bushels of wheat would it take to fill 750 hektoliters?
4. Reduce 35.781 sq. yd. to sq. in.
5. Reduce 10240 sq. rd. to sq. ch.
6. How many perches of masonry in a rectangular solid wall 40 ft. long by $7\frac{1}{2}$ ft. high, and $2\frac{2}{3}$ ft. average thickness?
7. How many ounces troy in the Brazilian Emperor's diamond, which weighs 1680 carats?
8. Reduce 75 pwt. to ʒ.
9. Reduce $\frac{4}{7}$ gr. to ℥.
10. Reduce $18\frac{3}{4}$ ʒ to oz. av.
11. Reduce 96 oz. av. to oz. troy.
12. How many gal. in a tank 3 ft. long by $2\frac{1}{4}$ ft. wide and $1\frac{1}{2}$ ft. deep?
13. How many bushels in a bin 9.3 ft. long by $3\frac{5}{8}$ ft. wide and $2\frac{1}{4}$ ft. deep?
14. How many sters in 75 cords of wood?
15. Reduce $2\frac{1}{4}$ years to seconds.
16. Forty-nine hours is what part of a week?
17. Reduce 90.12 kiloliters to liters.
18. Reduce 25″ to the decimal of a degree.
19. Reduce 192 sq. in. to sq. yd.
20. Reduce $6\frac{2}{3}$ cu. yd. to cu. in.
21. Reduce \$117.14 to mills.
22. Reduce 6.19 cents to dollars.
23. Reduce 1600 mills to dollars.
24. Reduce $\$5\frac{3}{8}$ to mills.
25. Reduce 12 lb. av. to ℔. troy.
26. How many grams in 6.45 quintals?
27. Reduce .216 gr. to oz. troy.

28. Reduce 47.3084 sq. mi. to sq. rd.

29. Reduce $4\frac{1}{2}$ ℈ to ℔.

30. Reduce $7\frac{1}{9}$ oz. av. to cwt.

31. Reduce 99 yd. to miles.

32. How many acres in a rectangle 16.02 rd. wide?

33. How many cubic yards in a box $6\frac{1}{4}$ ft. long by $2\frac{1}{2}$ ft. wide and 3 ft. high?

34. Reduce 169 ars to square meters.

35. Reduce $2\frac{1}{2}$ f℥ to ♏.

36. If a piece of gold is $\frac{6}{7}$ pure, how many carats fine is it?

37. In $18\frac{3}{4}$ carat gold, what part is pure and what part alloy?

38. How many square meters of matting are required to cover a floor, the dimensions of which are 6 m., $1\frac{1}{2}$ dm. by 5 m., 3 cm.?

39. How many cords of wood in a pile 120 ft. long, $6\frac{1}{2}$ ft. wide, and $8\frac{3}{4}$ ft. high?

40. How many sq. ft. in the four sides of a room $21\frac{1}{2}$ ft. long, $16\frac{1}{2}$ ft. wide, and 13 ft. high?

41. What will be the cost of 27 T. 18 cwt. 3 qr. 15 lb. 12 oz. of potash, at $48.20 a ton?

42. What is the value of a pile of wood 16 m., 1 dm., 5 cm. long, 1 m., 2 dm., 2 cm. wide, and 1 m., 6 dm., 8 cm. high, at $2.30 a ster?

43. What is the cost of a field 173 rods long and 84 rods wide, at $25.60 an acre?

44. If an open court contain 160 sq. rd. 85 sq. in.; how many stones, each 5 inches square, will be required to pave it?

45. A lady had a grass-plot 20 meters long and 15 meters wide; after reserving two plots, one 2 meters square and the other 3 meters square, she paid 51 cents a square meter to have it paved with stones: what did the paving cost?

46. A cubic yard of lead weighs 19,128 lb.: what is the weight of a block 5 ft. $3\frac{1}{4}$ in. long, 3 ft. 2 in. wide, and 1 ft. 8 in. thick?

47. A lady bought a dozen silver spoons, weighing 3 oz. 4 pwt. 9 gr., at \$2.20 an oz., and a gold chain weighing 13 pwt., at $\$1\frac{1}{4}$ a pwt.: required the total cost of the spoons and chain.

48. A wagon-bed is $10\frac{1}{2}$ ft. long, $3\frac{1}{2}$ ft. wide, and $1\frac{1}{2}$ ft. deep, inside measure: how many bushels of corn will it hold, deducting one half for cobs?

49. If a man weigh 160 lb. avoirdupois, what will he weigh by troy weight?

50. The fore-wheel of a wagon is 13 ft. 6 in. in circumference, and the hind wheel 18 ft. 4 in.: how many more revolutions will the fore-wheel make than the hind one in 50 miles?

51. An apothecary bought 5 ℔. 10 ℥. of quinine, at \$2.20 an ounce, and sold it in doses of 9 gr., at 10 cents a dose: how much did he gain?

52. How many steps must a man take in walking from Kansas City to St. Louis, if the distance be 275 miles, and each step, 2 ft. 9 in.?

53. The area of Missouri is 65350 sq. mi.: how many hektars does it contain?

54. A school-room is 36 ft. long, 24 ft. wide, and 14 ft. high; required the number of gallons of air it will contain?

55. Allowing 8 shingles to the square foot, how many shingles will be required to cover the roof of a barn which is 60 feet long, and 15 feet from the comb to the eaves?

56. A boy goes to bed 30 minutes later, and gets up 40 minutes earlier than his room-mate: how much time does he gain over his room-mate for work and study in the two years 1884 and 1885, deducting Sundays only?