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# ARITHMETICAL EXERCISES

AND

EXAMINATION PAPERS



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# ARITHMETICAL EXERCISES

AND

EXAMINATION PAPERS.

WITH AN APPENDIX

*CONTAINING QUESTIONS IN LOGARITHMS AND  
MENSURATION.*

*WITH ANSWERS*

BY

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## PREFACE.

IN this book we have followed the same plan as in our *Algebraical Exercises and Examination Papers*: the contents comprise eighty progressive miscellaneous Exercises, followed by a collection of fifty Papers set at recent Examinations, and an Appendix containing miscellaneous examples in Logarithms and Mensuration.

The EXERCISES are arranged as follows :

Part I. includes Decimals, Practice, Simple Proportion, and Simple Interest; Part II. takes in Compound Proportion, Percentages, Averages, and Proportional Parts; in Part III., Square Root, Areas, and Volumes are introduced; Part IV. includes Discount and Compound Interest; Part V., Profit and Loss and Stocks; Part VI., Cube Root and Duodecimals.

The EXAMINATION PAPERS will be found to comprise specimens of papers set at all the most important examinations in which a knowledge of Arithmetic is required; namely, The College of Preceptors, London University Matriculation, Oxford Local, Cambridge Local, Oxford and

Cambridge School Examination, Responsions, Previous Examination, Scotch Leaving Certificate.

The APPENDIX consists of two hundred graduated questions in Logarithms and Mensuration, arranged in twenty papers of ten questions, preceded by a list of numerical constants and formulæ in Mensuration. We hope that this last section of the book will be found especially useful, not only for students preparing for the examinations in which a knowledge of Mensuration is required, but also as furnishing an instructive sequel to the higher parts of Arithmetic.

H. S. HALL,  
S. R. KNIGHT.

*June, 1888.*

#### PREFACE TO THE THIRD EDITION.

In the second edition the Appendix was enlarged by including a series of one hundred Examples to be worked by the aid of Logarithmic Tables; in the present edition fifty more examples have been added to this section. Each Exercise has been carefully graduated, beginning with a few easy, straightforward examples, and leading up to others which require some thought and ingenuity besides the mere accurate manipulation of the Tables. It is hoped that by working through this section, a student will be enabled not only to master the preliminary difficulties of logarithmic calculation, but also to acquire some facility in dealing with a class of questions of growing importance in many Examinations.

*Jan., 1892.*

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# ARITHMETICAL EXERCISES.

## PART I.

*Including Decimals, Practice, Simple Proportion, and Simple Interest.*

### EXERCISE I.

1. SUBTRACT forty thousand and three from ten millions and two.

2. Divide 34568135 by 357, and £289. 0s. 8½d. by 17.

3. Twelve tons of tobacco were sent out to be divided amongst twenty-one thousand soldiers; how many pounds ought each man to receive?

4. Reduce 3 miles 5 fur. 30 poles 3 yds. to feet.

5. Reduce  $\frac{1485}{2160}$  to its lowest terms; and subtract  $14\frac{51}{140}$  from  $16\frac{4}{35}$ .

6. Multiply £2. 10s. 4d. by  $3\frac{5}{12}$ .

7. How many articles each worth £2. 10s. 3¼d. can be bought for £40. 5s.?

8. Simplify  $1\frac{2}{5}$  of  $\frac{1}{1\frac{1}{2} + \frac{1}{3\frac{1}{3}}} \div \frac{5\frac{1}{3} + 3\frac{1}{5}}{6\frac{1}{5} + 10\frac{1}{3}}$ .

**EXERCISE II.**

1. A person buys  $6\frac{3}{4}$  yards of silk at 18s. 6d. a yard, and  $10\frac{3}{4}$  yards of cloth at 5s. 4d. a yard; how much does the bill amount to?

2. Find the Greatest Common Measure of 42237 and 75582.

3. Find the value of

$$(1) \quad 3\frac{3}{8} + 2\frac{5}{6} + \frac{7}{12} + 3\frac{4}{9}. \quad (2) \quad 5\frac{1}{3} \text{ of } 4\frac{1}{2} - 3\frac{1}{4} \text{ of } 3\frac{1}{5}.$$

4. Find the weight of a million of pence, each weighing half an ounce.

5. Divide  $3\frac{3}{14} - 4\frac{7}{8} + 1\frac{19}{24}$  by  $1\frac{3}{8} + 5\frac{17}{21} - 7\frac{1}{24}$ .

6. Reduce £1. 11s.  $1\frac{1}{2}$ d. to the fraction of £2. 18s.  $9\frac{1}{2}$ d.

7. Find the difference between the greatest and least of the fractions  $\frac{5}{8}$ ,  $\frac{11}{16}$ ,  $\frac{4}{7}$  and  $\frac{7}{10}$ : also what is the difference between the other two?

8. How long will a person take to walk 16 miles, if he takes 110 steps of  $2\frac{1}{2}$  feet every minute?

**EXERCISE III.**

1. How many pounds of tea at 3s.  $7\frac{1}{4}$ d. a pound can be bought for £7. 0s.  $6\frac{3}{4}$ d.?

2. Multiply £63. 14s. 2d. by 17,  
and divide 987 miles 36 poles 5 yds. 7 in. by 55.

3. Find the Least Common Multiple of

$$(1) \quad 9669 \text{ and } 16115. \quad (2) \quad 75, 100, 120, 150.$$

4. Divide £8. 11s.  $11\frac{3}{4}$ d. by  $3\frac{5}{12}$ .

5. Find the value of

$$\frac{3}{8} - 2\frac{1}{2} + 5\frac{5}{32} - 3 + 1\frac{3}{4} - \frac{17}{32}.$$

6. Reduce  $5\frac{1}{2}$  pecks to the fraction of 22 gallons.

7. Reduce to its simplest form

$$\frac{9}{32} \text{ of } \frac{41}{162} - \frac{3}{54} \text{ of } \left(4\frac{1}{5} - 2\frac{1}{2}\right).$$

$$\frac{4}{9} + \frac{1}{2}$$

8. Find the difference in grains between the weight of a pound of feathers and a pound of gold.

How many pounds Troy are there in a ton of gold?

### EXERCISE IV.

1. If 41 yards of cloth cost £4. 7s.  $1\frac{1}{2}d.$ , what is the price of a yard?

2. How long would it take to count ten millions twenty thousand three hundred at the rate of one hundred and fifty per minute?

3. Add together  $2\frac{7}{8}$ ,  $\frac{13}{14}$ ,  $5\frac{3}{7}$ ,  $\frac{19}{24}$ ; and find the difference between  $15\frac{26}{27}$  and  $19\frac{25}{63}$ .

4. Simplify  $\frac{1\frac{7}{9}}{9\frac{11}{11}} \times \frac{27}{12} \times \frac{2\frac{5}{6}}{160} \times \frac{15}{4\frac{34}{7}}$ .

5. Resolve into prime factors

$$3456, \quad 26244, \quad 99225.$$

What is the greatest number that will divide the above three numbers?

6. What fraction of 25 yds. 1 ft. 5 in. is 14 yds. 1 ft. 8 in.?

7. Find the value of

$$\left(1\frac{7}{15} + 2\frac{1}{2}\right) \left(9\frac{1}{2} - 7\frac{4}{7}\right) \left(\frac{2}{3} - \frac{7}{15} - \frac{2}{45} + \frac{2}{5}\right).$$

8. A rupee is worth 2s.  $0\frac{1}{2}d.$ , and a dollar 4s.  $4\frac{1}{2}d.$ ; find the least number of rupees which makes an exact number of dollars.

**EXERCISE V.**

1. Add together 11·275, ·34132, ·00414, 23·001; and find the product of 22·5 and 32·16.

2. To how many persons may £60. 15s. 6d. be distributed, giving £4. 13s. 6d. to each?

3. The polar diameter of the earth is 41707796 feet; reduce this to miles, furlongs, &c.

4. Find the value of

$$(1) \frac{2}{5} \left( 6\frac{2}{3} + 2\frac{1}{2} \right) \div 3\frac{2}{3}. \quad (2) \text{£}75. 13s. 9\frac{1}{2}d. \times 3\frac{3}{4}.$$

5. Multiply 21·945 by ·0508, and divide ·68921 by ·0041.

6. Simplify  $3\frac{1}{4}$  of  $4\frac{1}{3}$

$$\left( 2\frac{1}{2} - \frac{1}{3} \right) \text{ of } \left( 3\frac{1}{2} - \frac{1}{4} \right).$$

7. Subtract  $\frac{13}{14}$  of  $\frac{1}{6}$  of a guinea from  $\frac{2}{5}$  of  $\frac{7}{16}$  of a sovereign, and express the difference as a fraction of half-a-crown.

8. What is the smallest sum of money which will exactly contain each of the following sums:

$$1s. 3d., \quad 1s. 4d., \quad 2s. 2d., \quad 1s. 8d., \quad 3s. 6d.?$$

**EXERCISE VI.**

1. If a grocer buys sugar at the rate of  $4\frac{1}{2}d.$  per lb. and sells it at 12s. per quarter, how much does he gain on each ton?

2. Find the sum of one-sixth of £37. 2s. 9d., one-twelfth of £29. 5s., and one-twenty-fourth of £32. 19s.

3. Reduce  $\frac{5}{80}$  and  $\frac{111}{125000}$  to decimals, and add the results together.

4. Reduce  $2\frac{1}{2}$  guineas to the fraction of £1 $\frac{1}{4}$ ; and express 3 roods 15 poles as the fraction of an acre.

5. Divide .075 by .00015 and .256399 by .7865.

6. Simplify  $\frac{\frac{1}{2} - \frac{1}{3}}{\frac{1}{2} + \frac{1}{3}}$  of  $\frac{\frac{1}{4} - \frac{1}{5}}{\frac{1}{4} + \frac{1}{5}}$  of  $\frac{\frac{1}{6} - \frac{1}{7}}{\frac{1}{6} + \frac{1}{7}}$  of 585.

7. Multiply 3 tons 17 cwt. 1 qr. 10.5 lbs. by .005.

8. Find the least number of weeks in which an exact number of half-guineas can be earned, the wages per week being 16s. 4d.

### EXERCISE VII.

1. Divide 7.53 by 2500, and .00144 by 19.2.

2. Express in the simplest form :

(1)  $\frac{5115}{8184}$       (2)  $\frac{2\frac{4}{5} - 1\frac{1}{2}}{4\frac{1}{5} - 2\frac{1}{4}}$  of £1. 10s.

3. Find the value of

(1) 17 tenths + 17 hundredths + 17 thousandths ;

(2) 101 tenths  $\times$  10 thousandths.

4. Find the sum of three-fifths of a sovereign, five-sixteenths of a shilling, and two-ninths of a guinea.

5. Reduce £7. 16s. 9½d. to the decimal of £8.

6. Simplify  $20\frac{4}{9} \times 1\frac{13}{23} \times \frac{7}{25} \div \frac{\frac{3}{4} \text{ of } 2\frac{1}{3}}{\frac{5}{6} \text{ of } 7\frac{1}{2}}$ .

7. Subtract .432 of an acre from 2½ roods, expressing the result in square yards and the decimal of a square yard.

8. One ounce Troy of gold is worth £3. 17s. 10½d.; find the value of a ton of gold.

**EXERCISE VIII.**

1. Reduce 80425 farthings to pounds, and 1364428 inches to miles, furlongs, poles, &c.

2. Find the greatest common measure of 1008, 2464, 504, and the least common multiple of 9138 and 21322.

3. Multiply  $\cdot 038$  by  $\cdot 0042$ , and divide  $\cdot 03217$  by  $6\cdot 25$ .

4. Simplify

$$(1) \frac{\frac{10}{3} + \frac{5}{6} - \frac{20}{21}}{\frac{5}{6} - \frac{4}{7}}.$$

$$(2) \frac{2}{2 + \frac{1}{4 - \frac{3}{4}}}.$$

5. Reduce three-fourths of half-a-crown to the decimal of £1. 10s.

6. Find the difference between one million three hundred and four farthings, and sixty-two thousand four hundred and fifty-nine fourpenny pieces.

7. Express as a decimal

$$\cdot 0003 + \frac{817}{3125} - \cdot 00847 + \frac{361}{800}.$$

8. A bill of £3. 0s.  $11\frac{1}{2}d.$  has to be paid by several persons in equal shares; if three of them together pay 16s.  $7\frac{1}{2}d.$ , how many are there to share the cost?

**EXERCISE IX.**

1. Divide £283. 15s.  $7\frac{1}{2}d.$  by  $3\frac{3}{4}$ .

2. Reduce  $\frac{3538}{3782}$  to its lowest terms, and from

$$15\frac{11}{12} \text{ take } 2\frac{3}{5} + 3\frac{9}{10} + 5\frac{5}{12}.$$

3. Find the value of

$$(1) 22\cdot 5 \times \cdot 0241 \times \cdot 0024. \quad (2) 1708\cdot 4592 \div \cdot 00024.$$

4. Find by Practice the cost of 111 articles at 18s.  $7\frac{1}{2}d.$  each.

5. Reduce  $\frac{357}{3000}$  to a decimal, and  $\cdot 09765625$  to a fraction.
6. Find the difference between  $\frac{6}{7}$  of 15 acres 3 roods 35 poles, and  $\frac{7}{9}$  of 31 acres 2 roods 27 poles.

7. Simplify

$$(1) \frac{36\cdot4 - \cdot 374 + 2\cdot56}{\cdot 0006} \quad (2) \frac{1\cdot5}{\cdot 075} \times \frac{3\cdot25}{2\frac{1}{6}}$$

8. On a railway there are 30 telegraph posts to the mile; if a train passes 17 of these in a minute, at what rate per hour is it travelling?

### EXERCISE X.

1. Simplify  $\frac{1}{42} \left( 123\frac{3}{4} - 101\frac{2}{3} \right) \div \frac{159}{224}$ .
2. Reduce 2 tons 3 cwt. 7 lbs. to the decimal of 5 tons.
3. Find by Practice the value of 127 things at £9. 17s. 6d. each.
4. Divide  $\cdot 01$  by  $\cdot 002$ , and  $57\cdot528$  by  $3\cdot76$ .
5. Express 6 $\cdot$ 105 pounds Troy in grains, and 1 $\cdot$ 9375 bushels in gallons.
6. Find the simplest fraction equivalent to

$$\frac{\frac{22}{31} + \frac{3}{29}}{\frac{34}{41} + \frac{5}{19}} \div \frac{\frac{21}{37} + \frac{8}{23}}{\frac{10}{43} + \frac{13}{34}}$$

7. If a cwt. of metal costs £8. 19s. 8d., what is the value of a piece weighing 6 cwt. 1 qr. 25 lbs.?
8. The circumferences of the large and small wheels of a bicycle are 176 inches and 48 inches respectively; how many more turns does the small wheel make than the large wheel in a distance of fifteen miles?

**EXERCISE XI.**

1. Divide two millions four hundred and one thousand and five by three thousand one hundred and forty-seven.

2. Reduce  $\frac{5544}{6552}$  to its lowest terms, and find the value of

$$\frac{2}{11} \text{ of } 1\frac{2}{9} \text{ of } 5\frac{1}{3} \text{ of } \frac{1}{4}.$$

3. Express  $5\frac{7}{10}$  pence as the decimal of a sovereign, and 17 lbs. as the decimal of 1 qr.  $14\frac{1}{2}$  lbs.

4. Simplify the fractions :

$$(1) \frac{5}{6 + \frac{7}{8 + \frac{10}{11}}} \quad (2) \frac{1 + \frac{1}{3 - 1\frac{3}{4}}}{1\frac{1}{2}}.$$

5. Find by Practice the value of 431 pieces of cloth at £5. 17s.  $11\frac{1}{2}d.$  each.

6. Subtract '035 of a guinea from 1.427 of a shilling, giving the result in pence.

7. What is the rent of 113 ac. 2 ro.  $13\frac{1}{2}$  po. of land at £2. 5s. per acre?

8. If 5 fowls are worth 3 ducks, 14 ducks worth 5 geese, and 3 geese worth 2 turkeys, what is the price of a fowl when a turkey costs a guinea?

**EXERCISE XII.**

1. Multiply '0095 by '0168; and divide '016085 by 3.125.

2. Find the difference between

$$3\frac{2}{3} \text{ of } 5\frac{1}{2} \text{ of } \frac{7}{9} \text{ and } \frac{1}{3} \div 2\frac{2}{5}.$$

3. The cost of 4 acres of land is £121; what is the value per square yard?

4. Find by Practice the dividend on £2073. 6s. 3d. at 11s. 8d. in the pound.

5. Simplify 
$$\frac{8 - 4\frac{1}{2}}{2\frac{2}{3} + 1\frac{1}{2}} + \frac{2\frac{3}{5} \text{ of } 9}{2\frac{4}{11} \text{ of } 2\frac{3}{4} \text{ of } 1\frac{2}{3}}.$$

6. Add together  $\frac{3}{5}$  of a guinea and a half,  $\cdot 855$  of a sovereign, and  $1\frac{7}{17}$  of  $2\frac{3}{7}$  of  $1\frac{3}{4}$  of 18s.  $4\frac{1}{2}d.$

7. Reduce 7 fur. 32 po. 5 yds. to the fraction of 14 fur. 13 po. 3 yds. 2 ft.

8. Find the value in English money of 900·28125 francs when 24·25 francs are exchanged for a sovereign.

### EXERCISE XIII.

1. Reduce 3055709 seconds to days, hours, &c.

2. Find by Practice the cost of 1392 things at £3. 16s.  $2\frac{1}{4}d.$  per dozen.

3. If 17 men can do a piece of work in 68 days, how many men must be employed to do the work in 4 days?

4. Reduce  $\frac{4489}{3125}$  to a decimal, and  $\cdot 390625$  to a fraction.

5. Add together  $\cdot 075$  tons, 2·195 cwt.,  $\cdot 145$  qrs., 3·6 lbs.

6. Find the value of  $5\frac{1}{3}$  of  $\frac{1}{1\frac{1}{3} + \frac{1}{2\frac{1}{4}}}$   $\div$   $\frac{4\frac{1}{5} + 5\frac{1}{4}}{4\frac{1}{4} + 3\frac{2}{3}}$ .

7. Find the value of 17 qrs. 3 bus. 1 gal. of corn at 1s.  $4d.$  the peck.

8. From a rod a yard long, portions, each  $\cdot 057$  of an inch long, are cut off; how many such portions can be cut off, and what will be the length of the remaining piece?

**EXERCISE XIV.**

1. If 39 acres of land cost £3627. 4s. 0 $\frac{3}{4}$ d., how much must be paid for 52 acres?

2. Subtract  $\frac{5\frac{4}{9}}{8\frac{10}{11}}$  of  $2\frac{5}{11}$  from  $5\frac{2}{7}$  of  $3\frac{9}{25}$  of  $\frac{40}{111}$ .

3. Find the cost of 27140 articles at £1. 13s. 6d. a score.

4. Multiply £2. 13s. 4d. by 1·30625, and divide £29. 12s. 6d. by 2·844.

5. Reduce fifty-seven millions six hundred and twenty thousand three hundred and eighteen square inches to acres, &c.

6. Simplify  $(\cdot 5 + \cdot 75) \times (2\cdot 5 - \cdot 4) \div \left(\cdot 125 + \frac{1}{4\cdot 8}\right)$ .

7. Resolve 999999 into its prime factors; and divide the product of 999999 and 1955 by the continued product of 37, 13, 17, 7, 23.

8. A person goes to France with £56, which he exchanges at the rate of 25 $\frac{3}{8}$  francs for a pound. He stays 30 days, and spends at the rate of 37 $\frac{1}{2}$  francs a day, and changes what he has left at the rate of 1 franc for 9 $\frac{1}{2}$ d. How much English money will he have?

**EXERCISE XV.**

1. Express as a decimal the sum of  $4\frac{37}{1250}$  and  $19\frac{35}{640}$ .

2. If 6 cwt. 2 qrs. 2 lbs. of sugar cost £9. 3s. 4d., how much will 4 cwt. 2 qrs. 7 lbs. cost?

3. Find the value of ·2272 of £14. 6s. 5 $\frac{1}{2}$ d.

4. Find the value of 51 things, four of which cost £19. 3s. 1d.

5. Reduce  $2\cdot4802\bar{7}$  to a fraction in its lowest terms.
6. Add the difference between  $\cdot035$  of a ton and  $\cdot064$  of a cwt. to the difference between  $\cdot27$  of a qr. and  $\cdot78$  of a lb., giving the result in lbs. and the decimal of a lb.
7. Find the value of a nugget of gold weighing 3 lbs. 11 oz. 8 dwts. 4 grs. at £3. 17s. 6d. per oz.
8. Three bells toll at intervals of 18, 24, 32 seconds: if they commence to toll together, what length of time will elapse before they toll together again?

### EXERCISE XVI.

1. Simplify  $6\frac{2}{3} - 3\frac{3}{4} + 4\frac{5}{6} - 3 + 1\frac{7}{8}$ .
2. Divide  $4\cdot3046721$  by  $\cdot0729$ , and express the product of  $5\frac{7}{8}$  and  $\cdot035$  as a fraction.
3. Find the value of  $7\frac{1}{4}$  of £3. 13s. 8½d. +  $2\frac{1}{10}$  of £5. 16s. 9¼d. -  $3\frac{1}{3}$  of £4. 17s.
4. If  $85\frac{1}{2}$  yards of cloth cost £24, how much will 114 yards cost?
5. Find the amount of £200. 16s. 8d. in  $2\frac{3}{4}$  years at  $3\frac{1}{2}$  per cent. simple interest.
6. Reduce 2 tons 19 cwt. 7 lbs. to the fraction of  
1 ton 12 cwt. 3 qr. 7 lbs.
7. Find the prime factors of 185625 and 101376, and deduce their greatest common measure.
8. Find the value of 2 roods 19 poles 19 sq. yds. of land at £40. 6s. 8d. an acre.

**EXERCISE XVII.**

- Express the sum of  $3\frac{9}{16}$  and  $2\frac{23}{25}$  as a decimal.
- If a ton of coal costs  $7s. 10\frac{1}{2}d.$ , find by Practice the value of 2135 tons.
- Find the product of  
 $2\frac{2}{7}$  of  $1\frac{4}{11}$ ,  $2\frac{5}{8}$  of  $\frac{4}{9}$ ,  $3\frac{1}{2}$  of  $\frac{1}{10}$ .
- If 5 ac. 3 ro. 4 poles of ground is worth £1125, what is the value of 44 ac. 3 ro. 1 pole?
- Find the simple interest on £620 for 5 months at  $2\frac{1}{2}$  per cent.
- Reduce 7 cwt. 3 qrs. 21 lbs. to the decimal of 1 ton, and find the value of  $\cdot 83$  of 11s.  $3d.$
- Sea-water contains  $2\frac{1}{2}$  parts in a hundred of salt; what weight of water would be required to yield half a ton of salt?
- If 8 ducks and 7 geese are sold for £3. 13s.  $9d.$ , and if 5 ducks are worth as much as 3 geese, find the price of a goose.

**EXERCISE XVIII.**

- Simplify  $\frac{1\frac{1}{8}}{1\frac{3}{14}} \div \left\{ \left( \frac{3}{17} \times 1\frac{1}{2} \right) - \frac{1}{18\frac{8}{9}} \right\}$ .
- If a train takes  $29\frac{3}{4}$  minutes to run  $10\frac{5}{8}$  miles, how many miles will it run in  $11\frac{3}{4}$  minutes?
- Express in minutes the sum of 2·6 days, and  $\cdot 85$  of an hour.
- A bankrupt pays  $13s. 10\frac{1}{2}d.$  in the £; if his debts are £7824, find by Practice the amount of his assets.

5. Find the simple interest on £255. 4s. 2d. for 2 years 5 months at 6 per cent.

6. Multiply  $4\cdot13\bar{6}$  by 44, and find the value of  $11\cdot129\bar{6}$  of £9.

7. If  $\frac{25}{37}$  of a field is worth £925, and if the land is worth £40 an acre, find the area of the field.

8. Express in pounds Avoirdupois the weight of a mass of gold which weighs  $18\frac{3}{4}$  lbs. Troy.

### EXERCISE XIX.

1. Find the least common multiple of 11, 30, 42, 66, 77, 90; and reduce  $\frac{5184}{19008}$  to its lowest terms.

2. Divide  $352\cdot95624$  by  $\cdot000504$ ; and express  $1\cdot4 \div 1\cdot1\bar{3}$  as a decimal.

3. Find the amount of £305. 2s. 1d. in  $3\frac{1}{4}$  years 4 per cent. simple interest.

4. Find the cost of 13724 articles at £12. 17s. 3d. each.

5. Reduce 3 tons 18 cwt. 3 qrs. to the decimal of  
13 tons 15 cwt. 2 qrs. 14 lbs.

6. The debts of a bankrupt amount to £2016 and his assets to £1764; how much does he pay in the £?

7. If a pound of sugar cost  $\cdot0703125$  of 16s., find the value of  $\cdot0625$  cwt.

8. A man has £578. 4s. per annum after paying income-tax at the rate of 4d. in the £; what is his income?

**EXERCISE XX.**

1. If 3 cwt. 1 qr. 23 lbs. of potatoes cost 19s. 8½*d.*, what will be the price of 4 cwt. 3 qr. 26 lbs.?

2. Find the product of

$$2\frac{10}{17}, 1\frac{33}{35}, \frac{28}{87}, 2\frac{13}{66}.$$

3. If a kilometre is equal to 1000 metres, and 35 yards are equal to 32 metres, express 77 miles in kilometres.

4. Find the interest on £816. 12*s.* 6*d.* for 5 years at 3½ per cent. simple interest.

5. Find by Practice the value of 2729 articles at £3. 17*s.* 6*d.* a dozen.

6. Express  $4\frac{238}{495}$  miles in miles, furlongs, &c.

7. If *A* can do a piece of work in 10 days, *B* in 15 days, and *C* in 30 days; how long will they take when they work together?

8. Coal is bought at 24*s.* per ton, and sold at 25*s.* 6*d.*; how many tons must be sold per year to realize an income of £350?

## PART II.

*Including Compound Proportion, Percentages, Averages,  
and Proportional Parts.*

### EXERCISE XXI.

1. Multiply 1 ac. 1 r. 1 p. 1 sq. yd. 1 sq. ft. 1 sq. in. by 30.
2. How much will 42 men earn in 30 days, if 69 men can earn £368 in 35 days?
3. Find by Practice the value of 12 cwt. 3 qrs. 16 lbs. at £2. 17s. 2d. per cwt.
4. Multiply the sum of  $2\frac{1}{4}$  and  $7\frac{5}{8}$  by 1·3, and add the result to the difference of  $2\cdot36\bar{4}$  and  $1\cdot697$ .
5. Find the simple interest on £780 for 35 weeks at 4 per cent. per annum simple interest.
6. If  $\frac{7}{15}$  of a guinea be taken from  $\frac{3}{12}$  of  $\frac{5}{9}$  of £5, what fraction of £3. 9s. will remain?
7. If the value of  $\frac{15}{19}$  of a field is £384, what is the value of  $\frac{5}{8}$  of the field?
8. How many lengths of .007 inches can be cut from a rod one foot long, and what is the length of the portion left?

**EXERCISE XXII.**

1. Find the difference between the product and the quotient of  $5\cdot312$  by  $\cdot0125$ .

2. Reduce  $3\cdot28125$  tons, and express 9 tons 14 lbs. as the decimal of 10 tons.

3. Find the interest on  $\pounds 256$ .  $13s.$   $4d.$  for 146 days at  $7\frac{1}{2}$  per cent. simple interest.

4. If the wages of 29 men for 54 days amount to  $\pounds 80$ .  $9s.$   $6d.$ , how many men must work 12 days to receive  $\pounds 407$ ?

5. Divide 
$$\frac{3\frac{2}{3} \times 9}{5 \times \frac{7}{8}}$$
 by 
$$\frac{\frac{1}{2} + \frac{1}{3} - \frac{1}{10}}{\frac{4}{9} - \frac{7}{18}}.$$

6. Find by Practice the value of 17 miles 7 fur. 60 yds. of iron rails at  $\pounds 17$ .  $12s.$  per mile.

7. Express the difference between  $\cdot714285\bar{5}$  and  $\cdot428571\bar{1}$  as a fraction in its lowest terms.

8. Find the smallest number by which the fractions  $\frac{5}{12}$ ,  $\frac{3}{16}$ ,  $\frac{4}{15}$  must be multiplied in order that the products may in each case be integral.

**EXERCISE XXIII.**

1. Divide  $\pounds 1272$ .  $9s.$   $1\frac{1}{2}d.$  by  $17\frac{3}{4}$ .

2. Express in the form of a decimal the sum of

$$50\frac{21}{25}, 3\frac{1}{160}, 8\frac{43}{100}, 28\frac{32}{3125}.$$

3. Find the cost of a telegram of 425 words at the rate of  $\pounds 1$ .  $12s.$   $6d.$  for twenty words.

4. How many horses will be required to plough 936 acres in 39 days, if 26 horses plough 1152 acres in 24 days?

5. Reduce five million four hundred and sixty-two thousand seven hundred and sixty-four square feet to acres.

6. Express 3 qrs. 8 lbs. 4 oz. 9 drams as the decimal of 27 tons.

7. Find the simple interest on £146. 12s. 2d. for 225 days at  $2\frac{1}{2}$  per cent.

8. A boy after spending two-fifths of his money finds that four-sevenths of what he has left is 1s. 9d.; how much had he at first?

### EXERCISE XXIV.

1. What is the least number which is exactly divisible by 272, by 612 and by 408? and what is the greatest number which will divide each of the above numbers?

2. Find the value of

$$3\frac{1}{2} - \frac{79}{120} - \left(5\frac{1}{4} - 4\frac{1}{3}\right) - \left(7\frac{1}{8} - 6\frac{1}{5}\right).$$

3. What is the amount of £30. 8s. 4d. in 234 days, allowing simple interest at 5 per cent.?

4. If 240 $\frac{5}{8}$  bushels of oats feed 16 horses for 13 $\frac{3}{4}$  days, how long will 13 horses take to consume 341 $\frac{1}{2}$  bushels?

5. Express  $\frac{1}{19}$  of £1. 2s. 6 $\frac{3}{4}$ d. + 125 of 11s. 8d. as a decimal of 1s. 9d.

6. Find the cost of a piece of building land containing 2 roods 17 poles at £345. 17s. 6d. per acre.

7. Simplify

$$\frac{1}{2} \text{ of } \frac{1}{2} + 1\frac{1}{3} + \frac{1}{9} \text{ of } \frac{2\frac{1}{5} + 4\frac{1}{3}}{1\frac{1}{5} - \frac{1}{9}}.$$

8. If 20 piastres are equivalent to £3. 7s. 6d., and 25·3 francs to £1, how many francs are equivalent to 2·5 piastres?

**EXERCISE XXV.**

- Multiply  $\cdot 02019$  by  $52\cdot 03$ , and divide  $\cdot 04312$  by  $\cdot 0044$ .
- If 49 men can empty a reservoir in 65 days pumping 8 hours a day, how many hours a day must 196 men work to empty it in 26 days?
- Find the value of  $2\cdot 1875$  of £1. 6s. 8d., and  $3\cdot 0259$  of £1. 13s. 9d.
- Divide
 
$$3\frac{3}{14} - 4\frac{7}{8} + 1\frac{19}{24} \text{ by } 1\frac{3}{8} + 5\frac{17}{21} - 7\frac{1}{24}.$$
- A bankrupt's debts are £3060, his assets £2300: how much will a creditor for £459 receive?
- A person has £2501. 5s. in a bank: what will be his loss in a year's interest when the bank lowers its rate from  $4\frac{1}{2}$  per cent. to  $3\frac{1}{4}$  per cent.?
- Find the sum of  $2\cdot 4$ ,  $\cdot 32$ ,  $\cdot 567$ ,  $7\cdot 056$ ,  $4\ 17$ , and  $\cdot 4304122$ .
- A man owns  $\frac{3}{17}$  of a mine, and sells  $\cdot 47$  of his share; what portion of the mine does he then retain?

**EXERCISE XXVI.**

- Find the value of
 
$$\frac{\left(3\frac{1}{3} - 2\frac{1}{2}\right) \div \left(\frac{5}{6} \text{ of } \frac{3}{8}\right)}{2\frac{2}{3} \div \left(\frac{1}{2} + \frac{1}{4}\right)}.$$
- Express in hours, minutes, seconds the difference between  $2\cdot 32$  hours and  $\cdot 325$  of a week.
- Add together
 
$$£3\frac{19}{100} \text{ and } 1\cdot 16 \text{ of half a guinea.}$$
- A farmer pays a rent of £2. 10s. per acre for 100 acres, of £3. 5s. per acre for 80 acres, and £4. 3s. 4d. per acre for 60 acres: what is his average rent per acre?

5. If 108 qrs. 1 bush. 1 peck of barley cost £201. 17s. 10d., what will 75 qrs. 2 bush. 3 pecks cost?

6. Find the value of  $\cdot 07890625$  of a ton, and simplify

$$1\frac{2}{3} \text{ of } \frac{\cdot 53}{\cdot 61} \text{ of } \frac{\cdot 825}{\cdot 416}.$$

7. Find the cost of 3 acres 1 rood 3 po.  $19\frac{1}{4}$  sq. yds. of land at £110 per acre.

8. If 27 men mow a field of 90 acres in 7 days, working 8 hours a day, how many men will be required to mow 200 acres in 16 days if they work 10 hours a day?

### EXERCISE XXVII.

1. Find by Practice the cost of 2510 lambs at 14s.  $7\frac{1}{4}d.$  each.

2. Find the simple interest on £820. 4s. 2d. for 2 years 146 days at  $2\frac{1}{2}$  per cent.

3. If  $16\frac{1}{4}$  tons of provisions last 2100 men for 13 days, what weight will be required for 4340 men for 42 days?

4. The average age of the 125 boys in the Fifth Forms of a school is 15·4 years, and the average age of the 35 boys in the Sixth Form is 16·7 years: what is the average age of Sixth and Fifth Forms taken together?

5. What fraction is a pound Troy of a pound Avoirdupois? Express their difference as a fraction of their sum.

6. Three persons *A*, *B*, *C* can do a piece of work in 10 days; if *A* takes 30 days, and *B* takes 45 days to do the same work, how long will *C* take?

7. Subtract  $\cdot 28571\frac{1}{4}$  of 13s. 6d. from the sum of  $\cdot 75$  guineas and  $\cdot 214285\frac{7}{8}$  of 13s. 4d.

8. Two friends during a walk take steps of  $2\frac{2}{3}$  and  $2\frac{3}{8}$  feet: if they start in step, how far will they have walked before they are in step again, and how many steps will each have taken?

**EXERCISE XXVIII.**

1. Find the value of '09921875 of a ton, and reduce 14 hrs. 15 min. to the decimal of  $3\frac{1}{2}$  days.

2. Divide the product of 619'3 and '117 by 1'43.

3. Find the cost of 47 qrs. 4 bus. 2 pks. 1 gal. 3 qts. 1 pt. at £1. 17s. 4d. per bushel.

4. Simplify

$$\left(\frac{1}{2} + \frac{2}{3}\right) \text{ of } \left(\frac{3}{4} + \frac{4}{5}\right) + \frac{5}{6} \text{ of } \left(\frac{1}{8} + \frac{1}{10}\right) + \left(\frac{1\frac{1}{2}}{22\frac{1}{2}} \div \frac{21\frac{1}{3}}{1\frac{1}{3}}\right).$$

5. A man whose annual income is £945 at the end of the year finds that he has saved 80 guineas: what percentage of his income has he spent?

6. If 23 cows are worth 5 horses, and 7 horses cost £362. 5s., find the cost of 14 cows.

7. Express £125 as a fraction of '83 of a guinea.

8. A man receives 4 per cent. on one-third of his capital,  $4\frac{1}{2}$  per cent. on one-sixth, and 5 per cent. on the remainder: what percentage does he receive on the whole?

**EXERCISE XXIX.**

1. Divide 5'681 by '0019, and multiply the quotient by  $\frac{2}{23}$  of '0001569.

2. Simplify

$$\left(3\frac{7}{18} \text{ of } \frac{426}{427} \div 71\right) + 2\frac{3}{70} \text{ of } \frac{3}{65} \text{ of } \frac{5}{44} - \frac{7}{190} \text{ of } 1\frac{11}{84}.$$

3. If 1 ton 16 cwt. 3 qrs. 10 lbs. of coal cost £2. 7s. 6d., how much can be bought for £17. 16s. 3d.?

4. If the Government buys 356 horses at £10. 15s. each and 508 horses at £11. 6s. 9d. each, how much on the average does each horse cost?

5. The sum of £5100 is to be raised by three towns of population 4250, 5250, 7500 respectively: if the towns contribute in proportion to their population, what does each town contribute?

6. Reduce 1 fur. 1 yd. 1 ft.  $1\frac{1}{2}$  in. to the decimal of a mile.

7. Divide  $\cdot 72390\bar{5}$  by  $2\cdot 1\bar{7}$ , and express the difference between  $1\cdot 538461\bar{5}$  and  $\cdot 07692\bar{3}$  as a fraction in its lowest terms.

8. A man embarks his whole capital in four successive ventures; in the first he clears 100 per cent., and in each of the others he loses 20 per cent.: shew that he has gained 2·4 per cent. on his original capital.

### EXERCISE XXX.

1. Find the simple interest on £244 8s. 4d. for  $2\frac{1}{2}$  years at  $3\frac{1}{2}$  per cent.

2. If a bankrupt pays 12s. 10d. in the £, how much will a creditor receive to whom he owes £754. 10s.?

3. Add together  $\frac{7}{20}$  of 2 tons;  $\frac{6}{7}$  of 1 ton 15 cwt;  $\frac{1}{63}$  of 1 cwt. 2 qr. 21 lbs.;  $\frac{5}{9}$  of 1 qr. 17 lbs. Also express the result as a decimal of 10 tons.

4. If 4 men mow 15 acres in 10 days of 7 hours, in how many days of  $6\frac{1}{2}$  hours can 7 men mow  $19\frac{1}{2}$  acres?

5. Divide £81. 10s. into four parts proportional to the fractions  $\frac{1}{2}$ ,  $\frac{2}{3}$ ,  $\frac{3}{4}$ ,  $\frac{4}{5}$ .

6. Express in its simplest form:

$$\frac{1\frac{2}{3} \text{ of } 1\frac{1}{4}}{3\frac{2}{5} + \frac{5}{19}} + \frac{4}{5 + \frac{6}{7 + \frac{8}{9}}}$$

7. A merchant gains 30 per cent. on one-third of his capital, 45 per cent. on one-fourth, and loses 15 per cent. on the remainder: what is his gain per cent. on the whole capital?

8. A railway passenger counts the telegraph posts on the line as he passes them: if they are  $58\frac{2}{3}$  yards apart, and the train is going 48 miles per hour, how many will he pass per minute?

## PART III.

*Including Square Root, Areas, and Volumes.*

### EXERCISE XXXI.

1. What quantity of silver can be bought for £36, when 14 lbs. 6 oz. 15 dwts. cost £45?
2. Find the cost of 2 cwt. 1 qr. 9 lbs. at £2. 6s. 8d. per ton.
3. Simplify  $\frac{6479}{6510} + \frac{4347}{4410} + \frac{6831}{6930}$ .
4. Reduce £16. 13s. 9d. to the decimal of £12, and 8 tons 17 cwt. 21 lbs. to the decimal of 3 tons 5 cwt. 2 qrs. 14 lbs.
5. Find the square root of 45064369.
6. A bankrupt owes three creditors £225. 10s., £376. 7s. 6d., £139. 2s. 6d. respectively; his assets being £463. 2s. 6d., how much will each creditor receive?
7. If 5.25 cwt. cost £4.2, find the cost of 14.875 tons.
8. If 10 scudi are equivalent to 52.5 francs, and 16s. to 20 francs, find how many carlini are equivalent to 500 scudi, twelve carlini being worth 4s. 2d.

### EXERCISE XXXII.

1. Multiply 1·65 by ·0091, and divide the product by ·000195.
2. Find the square root of 1383·0961 and of 8·027.
3. Express the product of 4·625 and ·027 as a fraction in its lowest terms.
4. How long will it take 51 horses to plough 1296 acres, if 34 horses plough 1680 acres in 35 days?
5. Find the simple interest on £252. 1s. 8*d.* from June 13 to August 25 at 3 per cent.
6. Find by Practice the value of a platinum bowl weighing 4 lbs. 6 oz. 15 dwts. 6 grs. at £1. 11s. 8*d.* per oz.
7. If the population of Blackburn increased from 75000 to 78125 during a certain period, find the percentage rate of increase.
8. When the income tax is 3*d.* in the £, a man's net income is £2370 per annum: what will it be when the income tax is 7*d.* in the £?

### EXERCISE XXXIII.

1. Find the least common multiple of 6870 and 10992; and the greatest common measure of 144, 216, 360, 504.
2. Reduce eight million eight hundred and sixty-eight thousand and ninety-seven square feet to acres.
3. Find the square root of ·0043046721 and of 2·00694.
4. Express the sum of ·236 of 4s. 7*d.* and ·516 of 10s. as the decimal of £1.
5. A person buys 20 lbs. of tea at 3s. 6*d.* per lb., 8 lbs. of coffee at 1s. 8*d.* per lb., and 3 cwt. of sugar at 3½*d.* per lb.: if the tradesman deducts 5 per cent. for ready money, how much has the person to pay?
6. If three pipes can separately fill a cistern in 17½, 19½, 21¾ minutes, how long will they take when running together?
7. How many times can ·053 be subtracted from 14·578, and what will be the magnitude of the remainder?
8. How much will a creditor lose to whom a bankrupt paying 8s. 10½*d.* in the pound owes £4970?

**EXERCISE XXXIV.**

1. If 41 horses eat 1066 bushels in 52 days, how many horses will eat 945 bushels in 35 days?
2. Reduce  $\frac{3}{125}$  to a decimal, and a guinea to the decimal of £4. 10s.
3. A bankrupt, whose whole property is worth £1344, owes £1792; how much in the pound will each creditor lose?
4. Find the rent of 4 acres 110 sq. yds. at £1. 18s. 6d. per acre.
5. Find the square root of 1.002001, and the square root of .1 to four places of decimals.
6. Divide 27.02 by .015 to four places of decimals, giving the exact value of the remainder.
7. A house is sold for £264. 5s. 3d. at a gain of £11. 2s. 9d., find the gain per cent.
8. Three persons *A*, *B*, *C* invested £6413, £5247, and £4081 in a business in which the net profits for one year were £1462. 6s. 0½d. : how should the profits be divided?

**EXERCISE XXXV.**

1. Find the square root of  $172\frac{9}{676}$ , and the square root of 20 to four places of decimals.
2. Find the value of  $\frac{3}{8}$  of an estate, when  $\frac{5}{24}$  of it is worth £1065.
3. Divide 61.0284 by .3501 to four places of decimals.
4. Find the cost of carpeting a room 24 ft. 4½ in. long by 23 ft. 4 in. broad at 4s. 6d. per sq. yd.
5. Simplify

$$\frac{1}{2 - \frac{3}{4 - \frac{5}{6}}} \times \frac{1}{2 + \frac{3}{4 + \frac{5}{6}}} \div 5\frac{4}{5}$$

6. Find the amount of a bill for 864 yds. of linen at 2s. 1d. per yd., 520 yds. of cloth at 1s. 3d. per yd., and 280 yds. of silk at 16s. 9d. per yd.: deducting  $7\frac{1}{2}$  per cent. for ready money.

7. A man leaves £32818 to be divided among his four sons in the proportion of the fractions  $\frac{2}{3}, \frac{3}{4}, \frac{4}{5}, \frac{5}{6}$ : find the share of each.

8. Two taps can separately fill a cistern in 10 and 12 minutes, and when the waste-pipe is open they can together fill it in 15 minutes; how long does the waste-pipe take to empty the cistern when the taps are not running?

### EXERCISE XXXVI.

1. Express the product of 2.25 and  $\cdot 03\bar{7}$  as a fraction in its lowest terms.

2. Find the value of 24 acres 3 roods 17 perches at £57. 10s. per acre.

3. Find the amount of £2060. 1s. 2d. in 3 years at  $4\frac{1}{2}$  per cent. simple interest correct to the nearest farthing

4. Express in feet the sum of 1.45 furlongs, 7.36 yards, 11.04 inches.

5. Find the square root of

$$(1) \ 101\frac{92}{169} \quad (2) \ 2704.416016.$$

6. Find the length of paper 2 ft. 9 in. wide required for the walls of a room 11 ft. high, 18 ft. 9 in. long, 17 ft. 3 in. broad.

7. Find the value of

$$3.27 \text{ of } 4s. 6d. + 7.45\bar{4} \text{ of } 16s. 6d. + .357142\bar{8} \text{ of } 3s. 6d.$$

8. *A*, *B*, *C* working together can do a piece of work in 6 days; *A* could do it alone in 24 days. After working together for 2 days, *A* is taken ill: how long will *B* and *C* take to finish it?

**EXERCISE XXXVII.**

1. Add together  $\frac{5}{9}$  of a guinea;  $\frac{3}{16}$  of a pound;  $\frac{7}{10}$  of a crown;  $\frac{5}{8}$  of a shilling.
2. Divide the cube of 1001 by the product of 77, 91 and 143.
3. Find the dividend of £3407. 15s. at 13s. 9d. in the £.
4. How many square feet of paper will be required for the walls of a room 9 ft. 6 in. high, 22 ft. 3 in. long, 17 ft. 4 in. broad?
5. A fraudulent dealer uses a weight of 15·75 oz. instead of 1 lb.: how much does he gain per cent.?
6. A boy swims 3 miles in  $5\frac{1}{2}$  hours: if he goes 2 ft. 8 in. at each stroke, find how many strokes he takes per minute.
7. What number has ·1 for its square root, and what number has ·01595169 for its square?
8. If 400 metres are equal to a quarter of a mile, find the number of square metres in a quarter of an acre.

**EXERCISE XXXVIII.**

1. Divide

$$2\frac{2}{15} + 2\frac{27}{35} - 3\frac{4}{21} \text{ by } 2\frac{5}{21} + 3\frac{1}{3} - 4\frac{6}{7}.$$

2. Find the cost of papering the walls of a room 10 ft. 8 in. high, 25 ft. 9 in. long, 18 ft. 5 in. broad, with paper 2 ft. 8 in. wide costing  $4\frac{1}{2}$ d. a yard.
3. Find the value of
 
$$\frac{\cdot 12825}{9\cdot 16} \times \frac{4\cdot 216}{\cdot 342} \times \frac{2\cdot 7}{1\cdot 5318}.$$
4. If 47 tons of old iron can be bought for £39. 19s., how many cwt. can be bought for 11s.  $8\frac{1}{4}$ d.?

5. The populations of three towns in 1871 are 50000, 80000, and 170000: in 1881 their populations have increased 16, 25, and 10 per cent. respectively: find the percentage increase of the total population of the three towns.

6. Find the square root of 2 to six places of decimals.

7. Find the distance in miles of a thunder-cloud when the thunder is heard  $17\frac{3}{5}$  seconds after the flash is seen; supposing that sound travels 1140 feet per second and that the flash is seen instantaneously.

8. If 10000000 acres are equivalent to 4046711 hectares, find to five places of decimals the number of square miles in a hectare.

### EXERCISE XXXIX.

1. Express  $\frac{3}{7}$  of a guinea as a decimal of £2, and find the value of  $\cdot 42857\bar{1}$  of 3 tons.

2. How many tiles  $3\frac{3}{4}$  inches long and  $2\frac{1}{2}$  inches broad will be required for a hall 21 ft. 3 in. long, 11 ft. 3 in. broad; and how much will they cost at the rate of 4s. 7d. per hundred?

3. If 2 cwt. 3 qrs. 18 lbs. of tea cost as much as 27 cwt. 2 qrs. 17 lbs. of sugar, what quantity of sugar should be given in exchange for 10 lbs. of tea?

4. Find the value of

$$\frac{1\frac{1}{2}}{4\frac{1}{3}} + \frac{3\frac{1}{3} - 2\frac{5}{6}}{4\frac{1}{2} + 5\frac{9}{10}} + \frac{3}{26} \text{ of } 6\frac{1}{4}.$$

5. Find the cost of a beam of timber 10 yds. long, 4 ft. broad, 9 in. thick at 10d. per cubic foot.

6. A mixture is made of 297 gallons of wine at 17s. 9d. per gallon, 132 gallons at 22s. 6d. per gallon, and 121 gallons at 19s. 4d. per gallon: find the value of a gallon of the mixture.

7. Divide £105 between *A*, *B*, and *C*, so that as often as *A* gets 4s. 6d. *B* may get 7s. 6d., and as often as *B* gets 5s. *C* may get 6s.

8. A kilolitre contains 35·32 cubic feet, and a gallon contains 277·274 cubic inches: how many gallons are there in a kilolitre?

**EXERCISE XL.**

1. Express as decimals  $\frac{5}{99}$ ,  $\frac{7}{999}$ ,  $\frac{16}{999999}$ ; also express their sum as a decimal.

2. If 143 men earn £852. 10s. in 6 weeks, in what time will 130 men earn £1550?

3. A roof 40 feet long, 28 ft. wide is to be covered with lead  $\frac{1}{10}$  in. thick: how many cwt. will be required, the weight of a cubic foot of lead being 12096 ounces?

4. Find the ratio of  $11\frac{2}{3}$  of 14 tons 4 cwt. 2 qrs.  $18\frac{2}{3}$  lbs. to 21 tons 7 cwt.

5. The floor of a room measures 14 ft. by  $12\frac{1}{2}$  ft. and is partly covered by carpet measuring  $11\frac{1}{2}$  ft. by  $9\frac{2}{3}$  ft., find the cost of covering the remainder with oil-cloth at 4s. 6d. per square yard.

6. Divide £11. 4s. between three men, four women, five boys, and six girls, in such wise that each woman has one-fourth less than a man, each boy two-sevenths as much as a man and a woman together, and each girl one-fifth as much as a man, woman, and boy together.

7. Find the number of yards in  
 $\cdot 635$  miles +  $\cdot 1045$  furlongs -  $1\cdot 75$  of 3 yds. +  $\cdot 142857$  of 1·4 feet.

8. Two men and three boys can level and turf 352 yards of a cricket ground in 4 days, and three men and two boys can complete 276 yards in 3 days: compare the amount of work done by a man and a boy.

## PART IV.

*Including Discount and Compound Interest.*

### EXERCISE XLI.

1. Find the square root of

$$(1) \ 253089 \cdot 4864. \quad (2) \ 2406 \frac{25}{9604}.$$

2. If a coining-press can strike off 1650 coins per hour, find the value of the coins which can be struck off by four presses working 10 hours a day for 18 days, and coining sovereigns, florins, shillings, and pence respectively.

3. A bankrupt's liabilities are £3758. 17s. 6d.; if he pays 13s. 7½d. in the £, find the value of his assets.

4. Find the compound interest on £3546 in three years at 5 per cent. per annum, correct to the nearest penny.

5. Reduce ·055 of £2. 17s. 11d. to the decimal of the difference between  $\frac{2}{3}$  of £5. 6s. 9d. and  $\frac{3}{5}$  of £1. 2s. 1d.

6. How long will *A* and *B* together take to do a piece of work which they can do singly in  $10\frac{1}{2}$  days and  $7\frac{1}{4}$  days respectively?

7. Subtract

$$4\frac{4}{4\frac{4}{9}} \text{ of } \frac{22\frac{1}{7}}{13\frac{1}{13} - 12\frac{1}{12}} \text{ from } 7 \div \frac{1\frac{1}{7} - 1\frac{1}{8}}{\frac{27}{28} \left( 3\frac{1}{2} + \frac{2}{7} \right)}.$$

8. Calculate the cost of paper for a room 18 ft. long, 16 ft. broad, and 12ft. high, allowing 40 sq. feet for doors and windows; the price of the paper being 2s. 4d. per piece of 12 yds. long and 21 inches broad.

**EXERCISE XLII.**

- Find the value of  
 $(\cdot 3648 \times 6\cdot 42) + (\cdot 0265756 \div \cdot 01)$ .
- How many times does a carriage wheel whose circumference is 17·125 feet turn round in a distance of 12·45 miles?
- Find to the nearest farthing the compound interest on £415 in 3 years at 6 per cent.
- Express 3 oz. 7 dwt. 12 grs. as the decimal of a pound Troy.
- Subtract

$$1\frac{1}{3} \text{ of } \frac{6\frac{2}{3}}{1\frac{1}{9}} \text{ from } \frac{1}{8} \text{ of } 13\frac{1}{2} \text{ of } \frac{8}{9} \text{ of } 4.$$

- Compare the rates of travelling of a bicyclist who goes 34½ miles in 2 hrs. 10 min. and a train which travels 59½ miles in 1 hr. 42 min.
- Find the rent of a field 198 yds. long, 165 yds. broad at £4. 6s. 8d. per acre.
- The 3 P.M. express from Paddington to Exeter stops first at Swindon, 77½ miles distant, at 4.27 P.M.; the whole journey is 194 miles, and 15 per cent. of the time is expended in stoppages: at what time is the train due at Exeter?

**EXERCISE XLIII.**

- Divide 3·714285 by 5·0571428, and express the answer as a decimal to four places.
- Find the value of

$$\frac{9}{11} + \left(2\frac{5}{6} \text{ of } 1\frac{1}{11}\right) - 1\frac{9}{17} \left(3\frac{2}{13} - 2\frac{1}{4}\right) + \frac{4\frac{9}{11} \text{ of } 2\frac{10}{17}}{1\frac{29}{51} \text{ of } 5\frac{3}{10}}.$$

- The debts of a bankrupt amount to £563. 15s., and his assets to £371. 2s. 8½d.; how much does he pay in the £?
- In a rectangular court which measures 192 ft. by 126 ft., there are four rectangular grass plots, each measuring 45 ft. by 27 ft.; find the cost of paving the remainder of the court at 8½d. per square yard.

5. Find the rent of 25 acres 3 roods 15 poles  $2\frac{3}{4}$  sq. yds. at £2. 15s. per acre.

6. Find to the nearest farthing the amount of £1256. 10s. in 2 years at  $3\frac{1}{2}$  per cent. compound interest.

7. Divide £146 between *A*, *B*, and *C*, so that as often as *A* gets 4s. *B* may get 5s. 4d., and as often as *B* gets 8s. 9d. *C* may get 7s. 6d.

8. A garrison of 1400 men has just provisions enough to allow 24 oz. of bread a day to each man for 36 days; but an engagement coming on, the garrison is increased by 400 men: how many ounces of bread per day must be assigned to each man so as to enable them to protract the siege for twenty days longer?

### EXERCISE XLIV.

1. Find the value of

$$1\frac{1}{11} - \frac{1 - \frac{7}{22}}{2 - \frac{1}{3}} + \frac{1\frac{2}{5}}{3\frac{1}{2}} - \frac{5\frac{5}{8}}{6\frac{1}{4}} \text{ of } \left( \frac{1}{5} - \frac{\frac{1}{2} - \frac{1}{3}}{4\frac{3}{4} - 3\frac{2}{9}} \right).$$

2. If 285 men can dig a trench in 120 days working 8 hours a day, how many men must be employed to do the same amount of work in 152 days working 10 hours a day?

3. Find the true discount on £962 in  $4\frac{1}{2}$  years at  $4\frac{1}{2}$  per cent.

4. Find by Practice the value of an alloy of gold weighing 5 lbs. 10 oz. 17 dwt. at £2. 2s. 6d. per oz.

5. Divide 4.761 by  $\frac{1.731}{.01}$ , and express the answer as a decimal.

6. A man has £642. 7s. 3d. per annum after paying income-tax at the rate of 4d. in the £: find his gross income.

7. Extract the square root of 10 to three places of decimals; and find the cost of putting a fence round a square field, whose area is four acres, at 1s. 6d. per yard.

8. A man rode a bicycle from *A* to *B*, a distance of 54 miles, at an average rate of 8 miles an hour; another man started from *A* on horseback half an hour after the bicyclist and arrived at *B* 15 minutes before him. Find the ratio of their speeds.

**EXERCISE XLV.**

1. Reduce the fractions  $\frac{6331}{15584}$  and  $\frac{6821}{17232}$  to their lowest terms, and then subtract the less from the greater.
2. Find the value of 4·0625 guineas, and reduce £13. 4s. 9½*d.* to the decimal of a sovereign.
3. In what time will £1500 amount to £1719. 7s. 6*d.* at 4½ per cent. simple interest ?
4. A cistern will hold 1 cub. yd. 14 cub. ft. 1224 cub. in. of water : if the inside length and breadth be 5 ft. 3 in. and 3 ft. 8 in. respectively, find the depth.
5. What fraction of 2 is the quotient of  $11\frac{1}{111}$  divided by  $16\frac{19}{37}$  ?
6. Find the price of 5 acres 3 roods 9 poles 27½ sq. yds. at £161. 6s. 8*d.* per acre.
7. Express  $\sqrt{\frac{.678 \times 9.01}{.0234}}$  correctly to the nearest integer.
8. A reef of quartz contains .0077 per cent. of gold : if it produces £9. 16s. per ton, find the weight of a sovereign in grains.

**EXERCISE XLVI.**

1. Find by Practice the value of 239 tons 16 cwt. 2 qrs. 22 lbs. at £2. 6s. 8*d.* per ton.
2. Find the present value of £959. 10s. 8½*d.* due 5 years hence, allowing simple interest at 3½ per cent. per annum.
3. Reduce  $\frac{7}{121}$  of half a rood to the decimal of  $\frac{10}{11}$  of an acre.
4. What length of paper 22½ inches wide would be required to paper the walls of a room 18 ft. 9 in. long, 13 ft. 6 in. broad, and 14 ft. 2 in. high ?

5. *A* and *B* together take 3 days to do a piece of work; *B* alone takes 8 days to do it: how long would *A* take working alone?

6. In 1871 the population of a town was 21456, and in 1881 it was 20115; find the percentage rate of decrease.

7. If  $1\frac{1}{2}$  yards of cloth are worth  $\frac{5}{12}$  of a bushel of corn, and 12 yards of cloth cost  $4\frac{1}{2}$  dollars, what is the value of 5 quarters of corn, a dollar being equal to 4*s.* 2*d.*?

8. The Scotch express runs from London to Edinburgh, a distance of  $393\frac{3}{4}$  miles, in 9 hours, making one stoppage of 30 minutes, three of 5 minutes each, and one of 3 minutes: what is its average speed when in motion?

### EXERCISE XLVII.

1. Reduce  $\cdot875$  of 17*s.* 6*d.* +  $\cdot16$  of £1. 8*s.*  $1\frac{1}{2}$ *d.* to the decimal of £7.

2. Add together  $\cdot5618$ ,  $2\cdot418$ ,  $\cdot1136$ .

3. Find to the nearest penny the amount of £8751. 15*s.* in 3 years at  $3\frac{1}{2}$  per cent. compound interest.

4. If a cubic foot of lead weighs 720 lbs., find the thickness of a sheet 18 ft. long and 6 ft. wide, weighing 1 cwt. 2 qrs. 12 lbs.

5. Of a regiment of soldiers  $\frac{1}{30}$ th are killed or disabled in the first battle,  $\frac{7}{29}$ ths of the remainder in the second battle, and  $\frac{3}{11}$ ths of the remainder in the third, and 512 men are left. How many were there at first?

6. What sum will amount to £470. 8*s.*  $10\frac{3}{4}$ *d.* in 4 years at  $2\frac{1}{2}$  per cent. simple interest?

7. A square field is bordered by a path three yards wide, the field and path together occupying  $2\frac{1}{2}$  acres; find the cost of covering the path with gravel at 1*s.* 6*d.* per square yard.

8. By weight distilled water contains 88.9 per cent. of oxygen, the rest being hydrogen: find the weight of hydrogen contained in 40 gallons of water, a gallon of water weighing 10 lbs.

**EXERCISE XLVIII.**

1. Multiply together

$$\frac{16\frac{9}{13}}{1\frac{38}{38}}, \frac{1\frac{8}{31}}{2\frac{22}{22}}, \frac{2\frac{16}{21}}{1\frac{33}{33}}, \frac{4\frac{1}{11}}{1\frac{49}{49}}, \text{ and } \frac{7}{22}.$$

2. Divide 7·0175 by 17·5 and 17·5 by 7·0175 correct to two places of decimals.

3. Find the smallest sum of which 14s. 7d., £1. 11s. 6d., and £3. 15s. are exact parts.

4. Find the value of a field 231 yards long, and 125 yards broad; an acre of land being worth £8. 16s.

5. In what time will £244. 1s. 8d. amount to £253. 4s. 8½d. at 3 per cent. simple interest?

6. A cistern has two pipes one of which can fill it in 2 hrs., the other in 3 hrs.; a third pipe can empty it in 5 hrs.: if while the cistern is empty all these are opened, in what time will it be one-quarter filled?

7. Find to the nearest farthing the compound interest on £450. 6s. 8d. for 2 years at 2 per cent., interest being payable half-yearly.

8. A river 30 feet deep, and 200 yards wide flows 4 miles an hour; find the number of tons of water that falls into the sea in a minute: a cubic foot of water weighing 1000 oz.

**EXERCISE XLIX.**

1. Find the least common multiple of 1701, 972 and 756, and add together  $\frac{4}{1701}$ ,  $\frac{5}{972}$  and  $\frac{11}{756}$ .

2. Divide ·37 by 1·17; multiply the result by the quotient of ·052 divided by 1·8, and give the result in the form of a fraction.

3. If a cubic foot of air weighs 1½ oz., find the weight in cwt. of the air contained in a room 15½ yds. long, and 21½ ft. broad, and 10 ft. 8 in. high.

4. At what rate per cent. simple interest will £276. 7s. 1d. amount to £309. 10s. 4d. in 3 years?

5. Find the mean proportional between 1692 and 2303; and the fourth proportional to 2401, 2058, 1764.

6. If 40 men can dig a trench in 4 days of 9 hours each, how many men must be employed to dig a trench twice as long as the former, half as wide again, and three-quarters of the depth, in 5 days of 8 hours?

7. Two clocks point to 2 o'clock at the same instant on the afternoon of Christmas day; one loses 8 seconds, and the other gains 7 seconds in 24 hours; when will one be half an hour before the other, and what time will each clock then shew?

8. The present worth of £159. 7s. 6d. due in a certain time is £150: if interest is allowed at the rate of  $2\frac{1}{2}$  per cent. find the time.

### EXERCISE L.

1. Subtract the square of  $\cdot 036$  from the square root of  $\cdot 0036$ .

2. Express  $\frac{1}{17}$  of £1. 0s. 2½d. +  $\cdot 875$  of 1s. 8d. as a decimal of 1s. 2d.

3. Find the present value of £2674. 6s. due at the end of 3 years at  $4\frac{3}{4}$  per cent.

4. Find, by Practice, the wages of a man working for 30 weeks 2 days 3 hours at 25s. a week, reckoning 6 days to a week and 12 hours to a day.

5. What length must be cut off a board  $16\frac{1}{2}$  inches wide and  $4\frac{1}{2}$  feet long so that the area of the part remaining may be 5 square feet?

6. A prize of £2770 was divided amongst three persons in the proportion of  $\frac{3}{4}$ ,  $\frac{14}{15}$  and  $\frac{5}{8}$ : find their respective shares.

7. A level tract of land, 21 miles long and  $\frac{3}{4}$  of a mile broad, is flooded to a depth of 5 feet: given that a cubic foot of water weighs  $62\frac{1}{2}$  lbs., find in tons the weight of water on the land.

8. The annual consumption of brandy in a country is 4500000 gallons, and the duty is 9s. 2d. per gallon; the duty is reduced 6 per cent., and the consumption then increases 8 per cent.; how is the revenue affected?

## PART V.

*Including Profit and Loss and Stocks.*

### EXERCISE LI.

1. Subtract  $7\frac{3}{125}$  of a furlong from  $1\frac{03}{125}$  of a mile, giving the result in yards and the decimal of a yard.

2. Find the amount of £1485 in 3 years at  $5\frac{1}{4}$  per cent. compound interest, neglecting fractions of a penny.

3. A bankrupt owes *A*, *B*, *C* respectively £65, £75. 3*s.* 4*d.*, £108. 8*s.* 4*d.*; his assets are £136. 14*s.* 5*d.*; what will each creditor receive?

4. If a publisher gains £2000 in selling 120000 shilling copies of a book, what is his gain per cent.?

5. Subtract

$$16\frac{1}{2} \times \frac{1\frac{3}{5}}{3 + \frac{1}{3\frac{1}{3}}} \text{ from } \frac{5\frac{2}{5} \text{ of } 7\frac{2}{9}}{8\frac{7}{24} - 3\frac{5}{12}}.$$

6. A roll of carpet 70 yards long and 30 in. wide weighs  $2\frac{3}{4}$  cwt.: how many rooms measuring  $18\frac{3}{4}$  ft. by  $17\frac{1}{2}$  ft. could be carpeted with a roll weighing 11 tons?

7. At what rate per cent. per annum will £1885. 15*s.* amount to £2569. 6*s.* 8*d.* in 7 years and 3 months simple interest?

8. Find the prime factors of 111540, 42336, and 67392, and thence find the quotients obtained by dividing their least common multiple by each of the numbers in turn.

**EXERCISE LII.**

1. Add together  $\frac{11}{35}$  of  $4\frac{1}{2}$  guineas,  $\cdot 615$  of a £, and  $3\frac{3}{11}$  of  $4\frac{5}{7}$  of  $1\frac{5}{9}$  of 16s. 7d.

2. By selling 10 acres of land for £4699. 8s. 3d. a person gained  $5\frac{1}{4}$  per cent.; how much did he give per acre?

3. Find the true discount of £619. 19s. 11d. due in 6 months, allowing interest at 3 per cent. per annum.

4. Multiply  $\cdot 3142857$  by  $\cdot 63$ , and express the quotient of  $\cdot 03$  by  $\cdot 285714$  as a decimal.

5. A bankrupt's debts amount to £4875. 5s., and his assets to £3250. 3s. 4d.: what will a creditor receive in payment of a debt of £574. 10s.?

6. Subtract 2'00751 quarts from '0865 of a bushel, and give the answer in pints and the decimal of a pint.

7. Brussels carpet is 2 ft. wide, costs 7s. 6d. a yard, and will last 5 years; Kidderminster carpet is  $2\frac{1}{2}$  ft. wide, costs 5s. a yard, and will last 3 years: find the ratio of their cost, not reckoning interest on the outlay.

8. A person received £525 as the interest on two sums of money, one of which was double of the other; he received 5 per cent. on the larger sum and 4 per cent. on the smaller: how much were the sums?

**EXERCISE LIII.**

1. Simplify

$$\frac{7}{11} \text{ of } \frac{19 - \frac{9}{49} - \frac{1}{27}}{\frac{1}{2} + \frac{1}{14} - \frac{5}{9}} \text{ of } \left( 3\frac{2}{5} + \frac{1}{2} - 2\frac{1}{10} \right).$$

2. If 5 cwt. 3 qrs. 8 lbs. of tea cost as much as 55 cwt. 1 qr. 6 lbs. of sugar, what quantity of sugar should be given in exchange for 15 lbs. of tea?

3. Extract the square root of 3263'8369; also of 65 to four decimal places.

4. A person walks 142·2 miles in 4·5 days travelling 10·164 hours a day: how many hours per day must he travel so as to walk 505·6 miles in 19·36 days?

5. Find by Practice the value of 945126 things at £1. 13s. 4d. a gross.

6. Find the cost of papering a room 15 ft. 11 in. long, 14 ft. 7 in. wide, and 9 ft. 9 in. high with paper  $\frac{2}{3}$  of a yard wide at 4d. a yard.

7. At what rate of interest will the present worth of £100. 10s. 3d. payable two years hence be £93. 10s.?

8. A draper buys 240 yards of silk; he sells  $\frac{1}{4}$  of it at a gain of 25 per cent.,  $\frac{1}{3}$  at a gain of 20 per cent., and the remainder at a loss of 15 per cent.; altogether he received £160: find the cost price per yard.

### EXERCISE LIV.

1. Express £3. 13s. 7½d. as the decimal of £5, and find the value of ·3416 of £1.

2. Find the amount of £415. 12s. 6d. in 3½ years at 3½ per cent. simple interest.

3. The cost price of a book is 16s. 8d.; if the publisher makes a profit of 17½ per cent., and the bookseller of 22½ per cent., find the retail price.

4. Find the sum of 3·16, 2·02345, 4·73813, giving the answer as a recurring decimal.

5. What must be the price of 3 per cent. Consols to give £1080 a year from the investment of £32850?

6. Subtract

$$1\frac{1}{15} \text{ of } \frac{2\frac{2}{7}}{4\frac{1}{9} - \frac{2}{2\frac{1}{3}}} \text{ from } \left\{ 3 + \frac{2\frac{1}{3} - 1\frac{5}{8}}{1\frac{1}{40} \left( 2\frac{1}{4} + \frac{3\frac{1}{2}}{6} \right)} \right\}.$$

7. Find the cost of covering completely a box 2 ft. by  $2\frac{1}{2}$  ft. by  $3\frac{1}{4}$  ft. with cloth  $\frac{5}{6}$  yard wide at 1s. 6d. a yard.

8. *A* and *B* can do a piece of work in 12 days; after working 2 days they are assisted by *C*, who works at the same rate as *A*, and the work is finished in  $6\frac{1}{4}$  days more: in how many days would *B* alone do the work?

### EXERCISE LV.

1. Find to the nearest farthing the compound interest on £2000 in 3 years at  $4\frac{1}{2}$  per cent. per annum.

2. If 7 men working 16 days can mow a field 1320 yards long and 880 yards wide, what will be the length of the side of a field 1320 yards wide which 4 men can mow in 42 days?

3. What quantity added to  $\frac{3}{4}$  of  $\left(\frac{4}{15} + \frac{1}{9}\right)$  will give  $3\frac{1}{4}$ ; and what quantity divided by  $3\frac{3}{7}$  of  $2\frac{7}{16}$  of  $1\frac{8}{13}$  will give  $\frac{4}{9}$ ?

4. In a stack of bricks 41 ft. 8 in. long, 16 ft. 8 in. wide, and 14 ft. 7 in. high there are 125000 bricks; if the length of a brick is 10 inches, and the thickness  $3\frac{1}{2}$  inches, what is the width?

5. What sum invested in the  $6\frac{3}{4}$  per cent. stock at  $138\frac{1}{2}$  will yield an annual income of £108? allowing brokerage of  $\frac{1}{8}$  per cent.

6. Find to five places of decimals the value of

$$\frac{1}{2} + \frac{1}{2 \cdot 3} + \frac{1}{2 \cdot 3 \cdot 4} + \frac{1}{2 \cdot 3 \cdot 4 \cdot 5} + \dots$$

7. During a rainfall of one inch  $100\frac{5}{8}$  tons of water fall on an acre of ground; how many ounces are there in a cubic foot of rain-water?

8. A wine-merchant buys gin at 12s. 6d. per gallon, and after adding water retails it at 13s. 4d. per gallon, thereby making 20 per cent. profit on his outlay; what proportion of water does he add to the gin?

**EXERCISE LVI.**

- Express as a decimal  $\frac{552}{2^5 \times 5^5} + \frac{923}{2^5 \times 5^7}$ .
- Find the value of 593 tons 18 cwt. 1 qr. 16 lbs. at £4. 13s. 4d. per ton.
- Add together 1.0536 of 3 lbs. 11 oz. and 2.307 of 15 drs., and give the answer in drams and the decimal of a dram.
- Find the value of

$$10 \frac{1}{2} \left\{ \frac{2\frac{1}{2}}{7} + \frac{3\frac{1}{2}}{9} \right\} - \frac{4\frac{1}{7} - 2\frac{1}{4}}{6\frac{1}{2} + 2\frac{1}{7}} \times 4\frac{30}{53}.$$

- In an examination in which the full marks were 6000, *A* got 12 per cent. more than *B*, *B* 16 per cent. more than *C*, and *C* 20 per cent. more than *D*: if *A* got 4872, find what percentage of the full marks were obtained by *D*.
- Find the change of income obtained by transferring £5400 Stock from the  $4\frac{3}{4}$  per cent. at 98 to the  $3\frac{3}{4}$  per cent. at 75.
- How many tiles 5 inches square would it take to line the bottom and sides and ends of a bath which is 100 ft. by 30 ft., and 5 ft. deep?
- If £125 in 3 years amounts to £140, in what time will £900 amount to £1050, the rate of interest being the same in both cases?

**EXERCISE LVII.**

- Find the dividend on £4146. 12s. 6d. at 11s. 8d. in £.
- Find the value of  $\frac{.384615}{2.142857}$  of £2. 2s. 3d.
- If 26 men in 9 days mow a field 780 yds. long and 660 yds. broad, how many men will mow a field 900 yards by 484 yards in 11 days?
- In what time will £381. 15s. 5d. amount to £393. 19s. 9d. at 4 per cent. per annum?
- Find the number of yards in the side of a square park containing 439 acres 33 perches  $5\frac{3}{4}$  sq. yds.

6. A grocer sells sugar at  $4d.$  per lb. and takes off 5 per cent. for cash payment: find what it costs him per cwt. in order that he may make a profit of 60 per cent.

7. If the discount on a bill due five months hence at  $3\frac{1}{2}$  per cent. per annum is £774. 12s. 6d., what is the amount of the bill?

8. By selling out 3 per cent. Consols at  $102\frac{3}{4}$ , and investing the proceeds in a railway stock which pays dividends of 7 per cent. per annum, a man finds that he can double his income: what is the price of the railway stock?

### EXERCISE LVIII.

1. A man's yearly income is £566. 13s. 4d., and he spends  $82\frac{1}{2}$  per cent. of it: how much does he save a year?

2. Reduce 2 miles 7 furlongs 18 perches 3 yards to the decimal of a league.

3. Find the income derived from the investment of £4470 in the  $4\frac{1}{2}$  per cents. at  $93\frac{1}{8}$ .

4. If a postage stamp is an inch long and  $\frac{4}{5}$  of an inch broad, how many stamps will be required for papering a room 18 ft. 10 in. long, 16 ft. 9 in. broad, and 9 ft. 6 in. high?

5. Simplify 
$$\frac{\frac{13}{111} + \frac{17}{47}}{1 - \frac{13}{111} \times \frac{17}{47}} - \frac{\frac{17}{15} - \frac{19}{47}}{1 + \frac{17}{15} \times \frac{19}{47}}.$$

6. It is found that 40 lbs. Troy of standard gold can be coined into 1869 sovereigns, the proportion of pure gold to alloy in standard gold being 22 to 2. How many grains of pure gold are there in a sovereign?

7. A wine-merchant buys whiskey at  $17s. 6d.$  per gallon, and after adding water to it in the proportion of 1 gallon to 6, retails it at  $18s.$  per gallon: what percentage of profit does he make on his outlay?

8. How many figures will there be in the repeating period of the decimal part of the sum of  $3\cdot013468\bar{2}$ ,  $2\cdot172\bar{1}$ ,  $\cdot006005341\bar{7}$ ? Where will the first figure of the period occur? Give reasons for your answer.

### EXERCISE LIX.

1. How many bricks 9 in. long,  $4\frac{1}{2}$  in. broad and 3 in. deep are there in a stack 30 ft. long, 16 ft. 6 in. broad and 9 ft. 3 in. high?

2. What sum will amount to £1027. 5s. 3d. in  $3\frac{5}{12}$  years at 4 per cent. simple interest?

3. Add together  $\cdot0021$  of a cwt.,  $\cdot045$  of a quarter,  $\cdot37$  of a lb., and subtract the sum from  $35\cdot263$  ounces. Give the answer in ounces and the decimal of an ounce.

4. A gallon of water weighs 10 lbs., and a cubic foot of water weighs 1000 oz.; how many gallons are there in a cubic foot?

5. Find the square root of  $223\frac{51869}{58564}$ .

6. A man invests £6104 in Consols when they are at  $95\frac{3}{4}$ , and sells out at  $97\frac{1}{4}$ : how much does he gain by the transaction?

7. If  $5\frac{1}{2}$  per cent. is lost by selling goods for £39. 12s. 9d., for what must they be sold in order to gain 5 per cent.?

8. If 8000 metres are equivalent to 5 miles, and if a cubic fathom of water weighs 6 tons, and a cubic metre of water 1000 kilogrammes, find the number of pounds Avoirdupois in a kilogramme.

### EXERCISE LX.

1. Find the value of

$$\cdot6\bar{5} \text{ of } 4\cdot1\bar{1} \text{ of } \frac{3\frac{2}{3}}{13} \text{ of } 2\cdot43\bar{2} \text{ of } 13s. 6d.$$

2. *A* and *B* each buy cigars at £2. 1s. 8d. per hundred; *A* sells them at 6d. each, while *B* sells them in bundles of 25 for 12s.: how much per cent. do they gain respectively?

3. If £720 is paid for bread to support 49 persons for 18 months when wheat is 42s. a quarter, how long will £705 support 94 persons when wheat is 49s. a quarter?

4. Find the change of income when £3800 Stock in the  $4\frac{1}{2}$  per cents. at  $96\frac{3}{8}$  is sold out and the proceeds are invested in the  $3\frac{1}{2}$  per cents. at  $75\frac{5}{8}$ ; the brokerage being 7s. 6d. in the £.

5. The walls of a room which is 21 ft. long, 15 ft. 9 in. wide, and 11 ft. 8 in. high are painted for £17. 17s.  $3\frac{1}{2}$ d.: find the additional expense of painting the ceiling at the same rate.

6. How much must a man invest in the  $3\frac{1}{2}$  per cents. at 91 in order to receive £590 per annum, after paying an income-tax of 4d. in the pound?

7. What principal will amount to £810. 6s. 9d. in 4 years at 5 per cent. compound interest?

8. *A* and *B* start at the same time from London to Blisworth, *A* walking 4 miles an hour, *B* riding 9 miles an hour. *B* reaches Blisworth in 4 hours, and immediately rides back to London. After 3 hours' rest he starts again for Blisworth at the same rate. How far from London will he overtake *A*, who has in the meantime rested 7 hours?

### EXERCISE LXI.

1. Express  $\cdot 37$  of £1. 4s.  $6\frac{3}{4}$ d. as a decimal of £9. 16s. 6d.; and find the value of £2·57 - 10·23s. + 13·84 farthings.

2. Find the cost of papering the walls of a room 23 ft. 4 in. square, 11 ft. 3 in. high, with paper  $\frac{5}{8}$  yds. wide, costing  $2\frac{1}{2}$ d. per foot.

3. Extract the square root of  $8636\frac{136}{225}$ .

4. Find by Practice the cost of 7 tons 6 cwt. 3 qrs. 14 lbs. at £5. 10s. 8d. a ton.

5. Sound travels at the rate of 1140 feet a second; if a shot be fired from a ship moving at the rate of 10 miles an hour, how many yards will the ship have moved before the report is heard at a place  $14\frac{1}{4}$  miles off?

6. Reckoning simple interest, what sum of money, lent out at 4 per cent. per annum, will produce in three years the same amount of interest as £540 lent out at 5 per cent. will produce in two years?

7. The map of a country is drawn on the scale of  $\frac{1}{10}$  of an inch to a mile: what area on the map will represent a lake 4000 acres in extent?

8. One company pays  $5\frac{1}{2}$  per cent. on shares of £100 each; another pays at the rate of  $3\frac{1}{2}$  per cent. on shares of £10 each; if the price of the former be £115. 10s., and of the latter £7. 15s., compare the rates of interest which the shares return to purchasers.

### EXERCISE LXII.

1. The debts of a bankrupt are £7320. 15s., and his assets are £4270. 8s. 9d.; how much will a creditor for £327. 6s. 3d. receive?

2. If eggs are bought at 18 for a shilling, how many must be sold for a sovereign so as to gain  $12\frac{1}{2}$  per cent.?

3. What fraction when multiplied by itself produces  $\frac{4880\frac{1}{3}}{5043}$ ?

What is the length of each side of a square court which contains 43785·5625 square yards?

4. Find the difference of income obtained by investing £13000 in a  $3\frac{1}{2}$  per cent. Stock at 91 and in a 4 per cent. Stock at 96.

5. Add together

3·807, 6·76435, 8·5486, ·0037, ·6571428, and 87·989;

and express as a decimal the value of

1·83 of ·954 of ·428571 of 2·25.

6. What is the least weight which can be expressed either by a whole number of Troy pennyweights or by a whole number of Avoirdupois ounces? Give the answer in Troy weight.

7. A closed vessel (in the form of a rectangular solid) made of metal 1 inch thick whose external dimensions are 8 ft. 4 in., 7 ft. 10 in., and 4 ft. 1 in. weighs 3 cwt. 1 qr. 8 lbs. Find the weight of a solid mass of metal of the same dimensions.

8. I have a certain sum of money wherewith to buy a certain number of nuts, and I find that if I buy at the rate of 40 a penny I shall spend 5*d.* too much, if 50 a penny 10*d.* too little. How many nuts have I to buy and how much to spend?

### EXERCISE LXIII.

1. Simplify  $\frac{1\frac{7}{9} \text{ of } \frac{27}{64}}{1\frac{1}{2} \text{ of } 9\frac{9}{11}} \div \frac{4\frac{4}{7} \text{ of } \frac{21}{160}}{2\frac{5}{6} \text{ of } \frac{15}{34}}$ .

2. Find the value of  $\cdot 01625$  of £204, 3*s.* 4*d.*; and reduce 8 lbs. 5 oz. 14 drs. to the decimal of a quarter.

3. A tradesman's prices are 20 per cent. above cost price, if he allows a customer 10 per cent. on his bill, what profit does he make?

4. Supposing a gallon to contain  $277\frac{1}{4}$  cubic inches, find approximately the number of gallons of water which would cover a square mile of ground to the depth of an inch.

5. Find the square root of  $\cdot 07$  to five places of decimals; and find the number of yards in the perimeter of a square field whose area is 97 ac. 2 ro. 25 po.

6. Find the alteration in income when £3200 Stock is transferred from the Three per Cents. at  $86\frac{3}{4}$  to the Four per Cents. Stock at  $114\frac{7}{8}$ ; the brokerage being  $\frac{1}{8}$  per cent. on each transaction.

7. *A* pays £9. 3*s.* 4*d.* more rates than *B*, their incomes being equal; living in different towns they are rated at 2*s.* and 1*s.* 4*d.* in the £ respectively: what is their income?

8. A legacy remains unclaimed for 4 years; at the end of that time it amounts to £14586. 1*s.* 6*d.* at 5 per cent. compound interest: what was the original bequest?

**EXERCISE LXIV.**

1. Divide 1·9517 by 673000 and 64000 by ·0008.

Reduce  $4\frac{173}{3125}$  and  $5\frac{43}{540}$  to decimals, and ·9375 and ·4925 to vulgar fractions.

2. Find the present value of £808. 1s. 4d. due 3 years and 9 months hence at 4 per cent. per annum simple interest.

3. Reduce 3 cwt. 3 qrs. 5 lbs. 4 oz. to the decimal of 1 ton; and find the value of that decimal of £4.

4. If 24 pioneers, in 2 days of 12 hours long, can dig a trench 140 yards long, 4 yards wide, and 2 yards deep, in how many days of 9 hours will 180 pioneers dig a trench 4 yards wide, 3 yards deep, and 980 yards long?

5. If the cost of papering a room  $8\frac{1}{4}$  yards long and  $6\frac{2}{3}$  yards wide with paper 2 feet wide at 4d. per yard be £2. 19s. 8d., find the height of the room.

6. *A* buys a pipe of wine and sells it to *B* at a profit of 5 per cent., *B* sells it to *C* at a profit of 5 per cent., *C* sells it to *D* for £49. 12s. 3d. making a profit of  $12\frac{1}{2}$  per cent.; what did the wine cost *A*?

7. *A* commences business with a capital of £4000, and after 4 months takes *B* into partnership with a capital of £300. Two months later they take *C* into partnership with a capital of £5000. At the end of the year their net profits amount to  $16\frac{2}{3}$  per cent. on the whole capital invested: what should each receive of the profits?

8. By selling out £4500 in the India Five per Cent. Stock at  $112\frac{1}{2}$  and investing the proceeds in a Chinese Seven per Cent. Stock a person finds his income increased by £168. 15s.: what is the price of the latter Stock?

**EXERCISE LXV.**

1. How many persons can be accommodated in a concert room which is 117 ft. long and 90 ft. wide; allowing a space of 2 ft. 3 in. by 1 ft. 6 in. for each sitting, and a gangway 3 ft. wide the whole length of the room?

2. A man has £576. 6s. 9d. per annum, after paying income-tax at the rate of 5d. in the £: what is his income?

3. Simplify

$$(1) \frac{8\frac{3}{5} - 7\frac{3}{4} + 5\frac{2}{3} - 4\frac{1}{2}}{13 - 11\frac{9}{10} + 10\frac{7}{9} - 9\frac{17}{20}} \text{ of } \frac{2}{11} \text{ of } 365.$$

$$(2) \frac{6 + \frac{1}{6 - \frac{1}{6}}}{4 - \frac{1}{4 - \frac{1}{4}}} \times 10\frac{8}{9}.$$

4. Find the value of .0013671875 of a mile, and reduce 21 lbs. 5¼ oz. to the decimal of a ton.

5. A person has £5000 Stock in the 3 per cents., which he invests in the 3½ per cents. at 87½, thus increasing his income by £5: find the price of the 3 per cents.

6. A gallon contains 277·274 cubic inches; a cubic foot of water weighs 1000 oz.: find approximately the number of gallons in a ton of water and the number of ounces in a pint.

7. At what distance from London will a train which leaves London for Rugby at 2.45 P.M. and goes at the rate of 41 miles an hour meet a train which leaves Rugby for London at 1.45 P.M. and goes at the rate of 25 miles an hour, the distance between London and Rugby being 80 miles?

8. If 3 per cent. more be gained by selling a horse for £83. 5s. than by selling him for £81, what was the original price?

## PART VI.

*Including Cube Root and Duodecimals.*

### EXERCISE LXVI.

1. Find the rate of interest obtained by buying at  $112\frac{1}{2}$  Railway Stock which pays a dividend of  $7\frac{1}{2}$  per cent.

2. Find by Duodecimals the area of a room which measures 17 ft. 5' 4" by 13 ft. 4' 6", expressing the answer in square feet, square inches.

3. In what time will the interest of £1640. 8s. 4d. be £98. 4s. 6d. at  $2\frac{1}{2}$  per cent. simple interest?

4. If 7 per cent. is lost by selling goods for £145. 6s. 3d., how much per cent. would be gained by selling them for £168. 15s.?

5. Find the cube root of 2815166·528.

6. Find the number of gallons of water which pass in ten minutes under a bridge 17 ft. 6 in. wide, the stream being 10 ft. 5 in. deep, and its velocity 8 miles an hour; having given that a gallon of water contains 277·2 cub. in.

7. The breadth of a room is half as much again as its height; its length is twice its height; it costs £5. 5s. to paint its walls at  $1\frac{1}{4}$ d. per square foot: what are its dimensions?

8. If the difference between the interest and discount on a sum of money for 2 months at  $4\frac{1}{2}$  per cent. be 2s. 3d., find the sum.

**EXERCISE LXVII.**

1. Find by Duodecimals the volume of a hole 14 ft. 2' 8" long, 7 ft. 10' 6" broad and 6 ft. 7' 6" deep.
2. If £960 amounts to £1200 at  $3\frac{1}{2}$  per cent. simple interest, at what rate per cent. will £1600 amount to £1920, the time in each case being the same?
3. Find the difference between the interest and the true discount on £264. 10s. for 3 years at 5 per cent. per annum simple interest.
4. If 4 per cent. is lost by selling silk at 10s. per yard, at what price per yard should it be sold in order to gain 5 per cent.?
5. If 10 sheep or 15 lambs can eat 40 bushels of turnips in 7 days, how long will it take 6 sheep and 18 lambs to eat 36 bushels?
6. Extract the square root of 1.07101801 and the cube root of 160103007.
7. Two horses can plough in a given time as much as 3 oxen, and the daily cost of 4 oxen is equal to that of 3 horses. A certain field can be ploughed by 3 horses in 8 days: find the cost of ploughing it by oxen in 6 days, the daily cost of a horse being 3s.
8. If the price of the 3 per cent. stock be 96, a person can obtain an annual income of £1 more than he can if the price be 97: how much has he to invest?

**EXERCISE LXVIII.**

1. Add 3.26 quarts to the difference between .302 of a bushel and .9273 of a peck, and give the answer in pints and the decimal of a pint.
2. On £2340. 6s. 8d. a profit of 2s.  $7\frac{1}{2}$ d. in the £ is made. Find by Practice the total profit.
3. Resolve 2310, 6552 and 12150 into their prime factors, and thence deduce their least common multiple.
4. Simplify  $\frac{.875 \times .270}{.125 + .125675} + \frac{3}{53}$ .
5. If a mile be equivalent to 1600 metres, find the number of square metres in  $7\frac{1}{2}$  acres.

6. It is desired to put a cubical case, whose content is 4019·679 cubic feet, through a square hatchway whose area is 37791·36 square inches: shew whether this can be done.

7. A sum of £5000 was invested in 3 per cent. stock at par, subject to an income-tax of 6*d.* in the £. Another sum of £5000 was invested in  $3\frac{1}{4}$  per cent. stock at 104, free from income-tax. Which investment was the more advantageous, and by how much?

8. What sum at compound interest will amount to £650 at the end of the first year and £676 at the end of the second year?

### EXERCISE LXIX.

1. Divide 1 by ·00375 and 3·81 by 2·227.

2. Reduce  $\frac{3}{110}$  of half a mile to the decimal of 6 poles; and find the product of  $1\frac{15}{29}$ ,  $4\dot{7}0\dot{2}$ ,  $\cdot 18\dot{6}$ ,  $5\cdot\dot{9}$ .

3. Supposing a linear yard to be  $\frac{32}{35}$  of a metre, find approximately the difference between a cubic yard and  $\frac{4}{5}$  cubic metre, expressing the answer in cubic inches.

4. When the exchange between London and Paris is 25 fr. 60c. for £1, and between Lisbon and Paris 537 $\frac{1}{2}$  centimes for 1 milreis, what is the value of a milreis in pence?

5. A person bought an estate and then sold it for £625 less than he gave for it, thereby losing  $1\frac{1}{4}$  per cent.: what should he have received in order to gain  $12\frac{1}{2}$  per cent.?

6. Find by Duodecimals the volume of a cube whose edge is 11 ft. 6 in. 5 pts., giving the result in cubic feet, inches and fraction of an inch.

7. The average temperature for Monday, Tuesday and Wednesday was 53°; the average for Tuesday, Wednesday and Thursday was 56°, that for Thursday being 60°. What was the temperature on Monday?

8. The 3 per cents. are at  $91\frac{1}{2}$  and the  $3\frac{1}{2}$  per cents. at  $\text{£}96\frac{1}{2}$ . A person has a sum of money to invest which will give him £100 more of the former stock than of the latter: find the difference of the income he could obtain by investing in the two stocks.

**EXERCISE LXX.**

- Express as decimals  $\frac{5}{11}$ ,  $\frac{1}{150}$ , and  $\frac{1.96845}{.72176}$ .
- Simplify  $\frac{44}{11 + \frac{1}{7 + \frac{3}{8 + \frac{1}{4}}}}$  of 3s. 5d.
- Find the value of 15 oz. 6 dwts. 17 grs. at 5s. 10d. an oz.
- Find the number of yards in the side of a square field of 1 acre 2 roods 4 poles 15 square yards.
- Find to a tenth of a gallon the number of gallons of water which a cistern 3 ft. 6 in. deep, 3 ft. 9 in. wide, and 4 ft. 2 in. long, can hold; a gallon containing 277.274 cubic inches.
- On heating a piece of metal its volume is increased 2.4 per cent.: by what percentage of the new volume does the metal decrease on cooling again to its original temperature?
- A person has £2950 stock in 3 per cent. Consols at  $83\frac{3}{8}$ ; when the funds have fallen  $2\frac{1}{2}$  he transfers his capital into 5 per cent. Italian loan at  $107\frac{1}{4}$ ; find the alteration in his income, the brokerage in each case being  $\frac{1}{8}$ .
- A can beat B in 100 yards by 5 yards, and C can beat B by  $14\frac{1}{2}$  yards in the same distance; by how much will C beat A in a mile race, the rates of running remaining uniform?

**EXERCISE LXXI.**

- Reduce £3. 17s.  $10\frac{1}{2}$ d. to the decimal of 5 guineas; and find the difference between 10 minutes and .063 of 2 hours 15 minutes 3 seconds.
- How many yards of paper 27 in. wide will be required to paper a room 15 ft. long, by 12 ft. wide, and 8 ft. 6 in. high? What will be the cost, supposing the paper to be sold at  $4\frac{1}{2}$ d. per yard?
- Find (by means of decimals, or otherwise) the amount of £745. 10s., in two years, at  $3\frac{1}{2}$  per cent., compound interest.



4. Find the value in English money of 1572·4185 francs when the exchange is at 26·675 francs per £.

5. Egyptian 7 per cents. being at 40, in how many years' time might the debt be repudiated without loss to an investor reckoning only simple interest, and considering the interest on safe investments to be 4 per cent.?

6. A person holding £2450 in the 3 per cent. Consols, sells out at  $93\frac{1}{2}$  and invests the proceeds in Russian  $4\frac{1}{2}$  per cents., whereby his income is increased by £31. 13s. 9d. At what price does he buy the Russian stock?

7. If the manufacturer makes a profit of 20 per cent., the wholesale dealer a profit of 25 per cent., and the shopkeeper a profit of 40 per cent., what was the cost of the manufacture of an article bought at a shop for 17s. 6d.?

8. With a tea worth half-a-crown a pound a dealer mixes an inferior quality worth 1s. 6d. a lb. In what proportion must he mix them so that by selling the mixture at the higher price he may gain 16 per cent.?

### EXERCISE LXXIII.

1. Find the present value of £188. 11s. 2d. due in 225 days at 4 per cent.

2. Find correct to 7 places of decimals the value of

$$\frac{1}{9} + \frac{1}{3 \cdot 9^3} + \frac{1}{5 \cdot 9^5} + \frac{1}{7 \cdot 9^7} + \dots$$

3. By selling a piece of land for £181. 12s. a man gained 13·5 per cent. : how much would he have gained or lost per cent. by selling it for £138. 8s.?

4. Eight bells, which toll at intervals of 1, 2, 3, 4, 5, 6, 7, 8 seconds respectively, begin tolling simultaneously; how many minutes must elapse before they all toll simultaneously again?

5. Find the number of square feet in the surface of a cube whose volume contains 2460375 square inches.

6. A person buys 3 per cent. stock at  $89\frac{3}{8}$ ; he receives one half-year's dividend, and afterwards sells his stock at  $94\frac{5}{8}$ , and finds that he has gained £54: what sum did he originally invest?

7. *A* walks to a place at the rate of  $4\frac{1}{2}$  miles per hour, at 8 miles from his destination he meets *B*, and turns back with him (walking at *B*'s rate) for a mile: if *A* is half an hour late at his destination, what is *B*'s rate, and at what rate should *A* have walked after parting with *B* so as to arrive at the proper time?

8. If a rectangular pathway which measures 787.5 metres in length and 1.525 metres in width is made at a cost of  $1\frac{1}{2}$  francs per square metre, find the length in yards of a similar pathway 6 feet wide, which costs 1s.  $1\frac{1}{2}d.$  per square yard, the total cost being the same: assuming £1 = 25 francs.

### EXERCISE LXXIV.

1. Reduce  $\cdot45$  of  $2\cdot16$  of 2s. 6*d.* to the fraction of  $\cdot027$  of  $1\cdot18$  of £5.

2. What principal will amount to £9239. 6s.  $3\frac{1}{4}d.$  in 3 years at  $3\frac{1}{2}$  per cent. per annum compound interest?

3. In what proportion must a merchant mix one kind of tea at 3s. per lb. with another at 1s. 6*d.* in order that by selling the mixture at 2s. 8*d.* per lb. he may make a profit of 25 per cent.?

4. Find to 7 places of decimals the value of

$$1.3 + \frac{1}{3.3^3} + \frac{1}{5.3^5} + \frac{1}{7.3^7} + \dots$$

5. One gallon of spirit which contains 11 per cent. of water is added to 3 gallons containing 7 per cent. of water, and to this mixture half a gallon of water is added: find the percentage of water in the mixture.

6. *A* and *B* start from the same point to run in opposite directions round a circular race-course, 9755 feet in circumference, *A* not starting until *B* has run 105 feet. They pass each other when *A* has run 4850 feet. Which will first come round again to the starting point (their speeds being uniform throughout) and what distance will they then be apart?

7. By buying 3 per cent. Consols at a certain price I find I obtain  $3\frac{3}{4}$  per cent. for my money and derive a net income therefrom, after paying an income-tax of  $6d.$  in the  $\pounds$ , of  $\pounds 421. 4s.$  Find the amount of stock and the price at which I bought it?

8. At an election  $A$  polled  $87\frac{1}{2}$  per cent. of the votes promised to him, and  $B$   $82\frac{1}{2}$  per cent. of those promised to him.  $A$  was returned by a majority of 28 votes; but if all those who promised had voted,  $B$  would have been returned by 160 votes: find the number of votes received by each.

### EXERCISE LXXV.

1. Find correct to 7 places of decimals the cube of  $3\cdot 1416$ ; and also the quotient of 1 by  $2\cdot 30258509$ .

2. Express  $4\cdot 0\dot{2}7 - 3\cdot 1\dot{0} + 5\cdot 8\dot{2}06\dot{3} - \cdot 14285\dot{7}$  as a recurring decimal.

3. Find by Practice the dividend on  $\pounds 7566. 16s.$  at  $13s. 10\frac{1}{4}d.$  in the  $\pounds$ .

4. In a game of billiards,  $A$  can give  $B$  twenty points in a hundred and  $B$  can give  $C$  fifteen points in a hundred: how many points should  $A$  give  $C$ ?

5. A person having 1033200 francs in the French 3 per cent. Rentes at  $74\cdot 4$  transferred to the English  $3\frac{1}{4}$  per cent. Consols at  $98\frac{2}{5}$ ; find the change in his income, the rate of exchange being  $\pounds 1 = 25\cdot 2$  francs.

6. A hare sees a hound 176 yards away from her and scuds off in the opposite direction at a speed of 12 miles an hour; thirty seconds later the hound perceives her and gives chase at a speed of 18 miles an hour. How soon will he overtake the hare, and at what distance from the spot whence the hare took flight?

7. Find the length of the edge of a cube of metal which cost  $\pounds 5407. 8s. 11\frac{1}{2}d.$ ; one cubic inch being valued at  $8s. 4d.$

8. The first of a series of cogged wheels, working into each other in a straight line, has a certain number of teeth; the number of teeth in the second is to that in the first as  $6 : 7$ ; of the third to the second as  $5 : 6$ ; and of the fourth to the second as  $2 : 3$ . If the wheels are set in motion, how many revolutions must each wheel make before they are simultaneously in their original positions?

**EXERCISE LXXVI.**

1. A farmer finds that each year his sheep increase at the rate of 20 per cent.: if at the end of 5 years he has 7776, how many had he to begin with?

2. Divide  $9\cdot16$  by  $\frac{1}{19\cdot63}$ , and find the value of  $\cdot03249$  of £69. 7s. 6d.

3. A man sold 150 one-hundred-pound shares of railway stock (which was paying 5 per cent.) at 105. With the proceeds he purchased 4 per cents. at 90 and resold them at 96. He then reinvested in the railway stock which was still at 105 and paying 5 per cent. What was the change in his income?

4. In what time would a cistern be filled by three pipes whose diameters are  $\frac{1}{2}$  in.,  $\frac{3}{4}$  in., and 1 in., running together, when the largest alone would fill it in 58 minutes; the amount of water flowing in by each pipe being proportional to the square of its diameter?

5. A merchant in London owes 1000 pistoles to a merchant in Cadiz; find how much he gains by sending it to him through France: the exchange being £1 = 25·4 francs and 19 francs = 1 pistole; 4 pistoles = £3.

6. One pendulum oscillates six times in 3·2 seconds, and another pendulum eight times in 3·6 seconds: if started simultaneously how often will they tick together in an hour?

7. What principal lent out at compound interest for 2 years at  $5\frac{1}{6}$  per cent. will amount to £4602. 10s. 1d.?

8. Determine the weight in pounds of a box, with a lid, made of wood  $\frac{3}{4}$  of an inch thick and measuring externally 4 ft. by 3 ft. by 3 ft., the weight of a cubic foot of wood being 38·4 lbs.

**EXERCISE LXXVII.**

1. Reduce  $\frac{5\cdot1183}{\cdot0141}$  of  $22\cdot2$  of  $\cdot09$  of  $\cdot234$  to a vulgar fraction in its lowest terms.

2. If £3 = 20 thalers, 25 thalers = 93 francs, 27 francs = 5 scudi, and 62 scudi = 135 gulden, how many gulden = £1?

3. A man, having 3 sons, left £9656 to be divided among them in proportion to their ages at the time of his death; when he died, their ages were 25, 22, and 21 years respectively: what was the share of each? and what difference would it have made to each of the sons if the father had lived a year longer?

4. A person sells 25 articles for the same money which he paid for 32; find his gain per cent. Also, if he sells 32 articles for the same money which he paid for 25, find his loss per cent.

5. If 75 men can perform a piece of work in 12 days of 10 hours each, how many men will perform a piece of work twice as great in a tenth part of the time, if they work the same number of hours in the day, supposing that two of the second set can do as much work in an hour as three of the first set?

6. What is the compound interest to the nearest penny on £83. 14s. 7d. in 7 years, at the rate of 3 per cent. per annum? Find the approximate time in which the simple interest on the same principal will be equal to this compound interest at the same rate per cent.

7. A person sells his property (the rental of which is £900) for £27118: he invests £4818 in the 3 per cents. at 100 $\frac{3}{8}$ , £2450 in the 5 per cent. Greek Securities at 50, and the rest of the money in the 4 per cent. New Zealand Stock at 99 $\frac{1}{4}$ ; find the increase in his income.

8. A cube contains 18·962 cubic yards; how many linear feet are there in (1) an edge, (2) a diagonal; and what is the total area of all its faces?

### EXERCISE LXXVIII.

1. Simplify

$$(1) \quad \frac{5}{14} \text{ of a ton} + \frac{7}{8} \text{ of 2 cwt.} + \frac{13}{14} \text{ of a qr.} + 98 \text{ lbs.} \\ - 3\frac{5}{7} \text{ of } 2\frac{9}{13} \text{ of a cwt.}$$

$$(2) \quad \frac{4\cdot285714 \text{ of } 3\cdot4}{1\frac{3}{10} \text{ of } 2\cdot428571} \times \frac{43 \text{ of } \cdot625}{\cdot24}.$$

2. Find to the nearest farthing, the price per lb. in English money of tea which costs in France 3·5 francs per kilogramme; £1 being equivalent to 25 francs and 1 kilogramme to 2·204 lbs.

3. A tradesman's prices are 12 per cent. above cash price: if he allows £1. 6s. 3d. discount on a bill of £21, what profit does he make per cent.?

4. A cistern containing 600 gallons measures externally 7 feet in length, 2 feet 11 inches in breadth, and 5 feet 6 inches in height: the sides being  $1\frac{1}{2}$  inches thick, what is the thickness of the bottom? (Given that 1 cubic foot of water contains  $6\frac{1}{4}$  gallons.)

5. Two clocks strike 9 together on Monday morning; on Tuesday morning one wants 8 minutes to 11 when the other strikes 11: how much must the slower be put on, that they may strike 9 together in the evening?

6. One vessel, *A*, contains 24 gallons of water; another, *B*, contains 12 gallons of wine. A gallon is taken from each, and is then poured into the other; this is done three times: how much wine and how much water will the vessels then contain?

7. An empty cistern has three pipes *A*, *B*, and *C*. *A* and *B* can fill it in three and four hours respectively, and *C* can empty it in one hour. If these pipes be opened in order at 1, 2 and 3 o'clock, find when the cistern will be empty.

8. A person sells an estate worth £1200 per annum for  $24\frac{1}{2}$  years' purchase, and after deducting  $1\frac{1}{2}$  per cent. for expenses invests the remainder in North-Eastern Consols at  $172\frac{1}{4}$ : allowing 2s. 6d. per cent. for brokerage, find the amount of stock he will receive. If the Stock pays 7 per cent. what will be the difference of his income, supposing the management of his estate to have cost him 10 per cent. of the rental?

### EXERCISE LXXIX.

1. If 48 pioneers, in 20 days of  $12\frac{1}{2}$  hours long, can dig a trench 139·75 yards long,  $4\frac{1}{2}$  yards wide, and  $2\frac{1}{2}$  yards deep, how many hours per day must 1740 pioneers work during 42 days, in order to dig a trench  $4910\frac{1}{8}$  yards long,  $4\frac{1}{2}$  yards wide, and  $3\frac{1}{2}$  yards deep?

2. A clock loses 5 seconds in every 24 minutes; at 10 P. M. on Sunday it is 19 minutes fast: when will it be at the right time exactly?

3. In a workhouse where there is always the same number of inmates to be fed, the contract price of meat rises 20 per cent., and the daily allowance of each person is at the same time reduced from 9 oz. to 8 oz. If the yearly charge for meat is thenceforward £597, what was it before the changes were made?

4. How much 3 per cent. Stock at  $98\frac{1}{2}$  must be sold out to purchase an estate whose rent is £172. 7s. 6d. a year? the estate being worth 24 years' purchase, and a commission of  $2\frac{1}{2}$  per cent. on the purchase money being paid to the land-broker.

5. Two cogged wheels work together, there being 32 cogs on one and 36 on the other. The larger wheel makes 64 revolutions per second: how often will the same cogs come in contact during 6 working days of 10 hours each?

6. *A* and *B* run a mile race; *A* goes 5 feet at each step, and takes 3.3 steps per second all through the race; *B* goes 6 feet at each step, and takes 3 steps per second for three-quarters of a mile, but in the last quarter he only goes 5.5 feet at each step, and takes 2.5 steps per second: which won the race, and what time did each take?

7. What must be the market value of 6 per cent. stock in order that, after deducting an income-tax of 10d. in the £, it may yield  $6\frac{1}{4}$  per cent. interest?

8. A person in London owes another in St Petersburg 920 roubles, which must be remitted through Paris. He pays the requisite sum to his broker, at a time when the exchange between London and Paris is 25.15 francs for £1, and between Paris and St Petersburg 1.2 francs for 1 rouble. The remittance is delayed until the rates are 25.35 francs for £1 and 1.15 francs for 1 rouble: express in English money the difference to the broker caused by the delay.

### EXERCISE LXXX.

1. A dealer purchasing spirit at 5 shillings per gallon, dilutes it with so much water that, selling it at 4s. 6d. per gallon, he gains 20 per cent. upon his outlay: how much water is there in every gallon of the compound?

2. A vessel whose speed was  $9\frac{1}{2}$  miles per hour, started at 8 A. M. to go a distance of 74 miles. A second vessel, whose speed was to that of the first as 8 to 5, starting from the same place, arrived five minutes before the first: when did the second vessel start?

3. If 15 men can perform a piece of work in 12 days of 10 hours each, how many men will perform a piece of work four times as great in a fifth part of the time, if they work the same number of hours in the day, supposing that 2 of the second set can do as much work in an hour as 3 of the first set?

4. Two trains on the same railway are running past each other in opposite directions, one 40 and the other 30 miles per hour. Each has an engine and tender; the first train has 12 carriages, the second 17. If the length of an engine and tender be 41 feet, and the length of a carriage 32 feet, and the coupling spaces be each 5 feet, how much time will elapse from the moment that the engines meet till the last carriages of each train have passed?

5. The specific gravities of hammered gold and silver are 19.76 and 10.45 respectively: find the ratio of the weights of a bar of gold measuring 4.18 inches long, 4.2 inches broad, .31 inches deep, and a bar of silver 13.02 inches long, 1.14 inches broad, .65 inch deep.

6.  $A$ ,  $B$ , and  $C$  can do a piece of work together in 60 days; after they have worked together for 10 days  $A$  withdraws, and  $B$  and  $C$  work together at the same rate for 20 days more;  $B$  then withdraws, and  $C$  completes the work in 96 days more, working  $\frac{1}{3}$  longer each day. Working at his former rate  $C$  alone could do the work in 222 days: find how long  $A$  and  $B$  would each take to do it separately.

7. A speculator bought Spanish bonds at 18, these yielded no interest; 18 Honduras bonds paying 10 per cent. at 35, and 27 Turkish paying 5 per cent. at 45. At the end of two years he sold the Honduras stock at 15, and at the end of the following year he sold the Spanish at 25, and the Turkish at 46. Including the interest he gained £1146: what number of Spanish bonds did he buy?

8. A tradesman professes to retail his goods at 10 per cent. profit, but adulterates them by adding one-quarter of their weight of an inferior article, which costs him four-fifths of the price of the better. How much per cent. profit does he make, and in what proportion should he mix the two kinds so as to gain 20 per cent.?

# EXAMINATION PAPERS.

## I.

*College of Preceptors.*

*Pupils' Examination. Midsummer, 1886.*

*(First Class.)*

1. If nineteen thousand five hundred and fifty hot-cross buns, made in one night, yield a net profit of one-eighth of a penny per bun, what is the night's total gain?

2. If 2 qr. 17 lb. of coffee cost £5. 3s. 5d., what is the value of 6 cwt. 14 lb.?

3. Find (by Practice) the cost of making a road 47 mi. 3 fur. 5 yd. long, at £38. 2s. 8d. a mile.

4. Reduce to their simplest forms:

$$\frac{342405}{661983}, \text{ and } \frac{1}{6} \text{ of } 12 \frac{3}{4} \text{ of } \frac{27}{85} \text{ of } \left( \frac{1}{4} + \frac{3}{5} - \frac{5}{7} \right) \text{ of } \frac{15}{19}.$$

5. Determine the values of  $\cdot 1636$  of 16s. 8d.;  $\cdot 27$  of £1; and multiply  $\cdot 1558730$  by 21.

6. Obtain the square of 9980; the cube root of 857375000; and the square root of 2.5, correct to three places of decimals.

7. Find the present worth of a Bill of £1013. 2s. 6d. due  $5\frac{1}{2}$  months hence, and discounted at 3 per cent. per annum.

8. Find the Compound Interest on £3600, accumulated during  $3\frac{1}{2}$  years, at  $2\frac{1}{2}$  per cent. per annum. If for the last half-year the interest be reduced to  $1\frac{7}{8}$  per cent. per annum, what will be the difference in the whole amount? (*Answer to the nearest farthing.*)

9. Investing a certain sum in a Railway paying £6 per £100 share, at a time when each share cost £125, I find my income £10. 14s. 6d. better than when I invested the same amount in 3 per cent. Consols at 95. Determine the amount.

10. A plot of land is valued at £1936 per acre: what is its worth in francs per square metre? ( $£1 = 25\frac{1}{7}$  fr.; a metre =  $39\frac{3}{8}$  inches.)

## II.

### *College of Preceptors.*

*Pupils' Examination. Midsummer, 1886.*

*(Second Class.)*

1. What sum will remain when four bills, amounting to £5. 17s. 4½d., £13. 4s. 7¾d., £2. 15s. 1d., and £10. 13s. 2¼d. respectively, have been paid out of £37?

2. Multiply 3 yd. 2 ft. 4 in. by 37; and reduce 193540000 square inches to acres, roods, &c.

3. If gold is worth £4. 3s. 4d. per ounce, what is the value of a bar weighing 4 lb. 5 oz. 5 dwt. 21 gr.?

4. Find the cost of excavating a ditch 1800 feet long, 7 feet wide, and 5 feet deep, at the rate of 1s. 6d. for every nine cubic yards.

5. Add  $\frac{3}{7}$ ,  $\frac{5}{8}$ ,  $\frac{17}{56}$ . Multiply and divide  $105\frac{4}{35}$  by  $4\frac{2}{7}$ . Reduce £1. 4s. 0¾d. to the fraction of £33, in its lowest terms.

6. Obtain the decimal equivalent to

$$(i) \frac{1}{8}; \quad (ii) \frac{3}{32000}; \quad (iii) \frac{452}{432}.$$

How may you know beforehand that (iii) will produce a recurring decimal?

7. Square 10162, and obtain the square root of 1032.66244 to three places of decimals.

8. Determine the amount of £3643. 6s. 8d. at  $3\frac{1}{2}$  per cent. Simple Interest, for  $4\frac{1}{2}$  years.

9. A dealer buys a machine for £525 cash, and sells it after nine months, for £423. 10s. How much did he lose, considering money worth 6 per cent. per annum?

## III.

*College of Preceptors.**Pupils' Examination. Midsummer, 1886.**(Third Class.)*

1. Take One hundred and thirty-one seventeen times, and add to it One hundred and seventeen, thirty-one times repeated; add to this sum Two thousand one hundred and nineteen, and multiply the result by Four hundred and sixty-eight.

2. How many pounds sterling, shillings, pence, and farthings in 19 guineas, 13 crowns, 21 florins, 16 shillings, and 7 farthings?

3. Find the value of 11 chests of tea, each containing 39 lbs. at 5s.  $7\frac{1}{4}d.$  a pound.

4. Divide 3964 tons 17 cwt. 1 qr. 11 lb. by 19 and by  $27\frac{1}{2}$ .

5. Explain how it is that  $\frac{3}{10}$  is the half of  $\frac{3}{5}$ .

6. Find the Highest Common Factor of 52, 78, and 416; and the Lowest Common Multiple of 12, 18, 30, 48, and 60.

7. Reduce each of the following fractions to its lowest terms:

$$\frac{825}{2709}, \quad \frac{630}{936}, \quad \frac{25194}{88179}$$

8. Find the value of  $\frac{2 \times \frac{5}{7} \times \frac{35}{9}}{\frac{1}{7} \times \frac{2}{3} \times \frac{84}{81}}$ , and take the result from

$$10\frac{3}{4} + 3\frac{9}{10} + 7\frac{24}{25}$$

9. A field is 121 yards long and 86 yards broad; what will be its value at £80 an acre?

10. In a train containing 310 passengers, the number of First and Third Class passengers was 220, that of the Second and Third Class 265. How many passengers were there in each Class?

## IV.

*College of Preceptors.**Professional Preliminary Examination. March, 1886.**(First Class.)*

1. Find the sum, difference, and product of 1234568 and 4321089. The last may be found by means of only three lines of multiplication.

2. The Austrian National Debt amounts to 2,306,236,856 florins. Express its amount in words, reduce its value to English money (an Austrian florin = 1s. 8d.), and find how many days it would take to count at the rate of 96 florins a minute, working 10 hours a day.

3. If a sovereign weighs 5 dwt. 8 gr., what is the value of 106 lbs. 9 oz. 16 dwt. of the same metal?

4. Find the Highest Common Factor of 226512 and 2909907, and the Lowest Common Multiple of 1176, 67914, and 3267.

5. A merchant, after trading for six years, died worth £73,426. 10s.; the first year he had increased his original capital by  $\frac{1}{6}$ , the second by  $\frac{1}{5}$ , the third by  $\frac{1}{4}$ ; the next two years by  $\frac{1}{3}$  and  $\frac{1}{2}$ , and the last year he had doubled his original capital. Find each year's increase of capital.

6. Simplify  $2\frac{4}{5} - \frac{1}{9}$  of  $\frac{5\frac{1}{7} - 2\frac{1}{4}}{1 + \frac{1}{3 + \frac{1}{6}}}$  of  $\frac{9\frac{1}{3}}{12\frac{1}{11}} \div 2\frac{1}{5}$ .

7. Find the value of  $3\frac{1}{5} + 9\frac{5}{8} + 7\frac{3}{4} + 41\frac{111}{125} + 1\frac{2}{3}$ , both by Vulgar Fractions and Decimals: show that the results coincide.

8. A can do a piece of work in  $10\frac{2}{3}$  days, B in  $9\frac{3}{8}$  days, and C in  $5\frac{2}{11}$  days: in how many days can A, B, and C, working together, complete the work?

9. Divide the cube of 1.236068 by 2.36068 correctly to five places of decimals.

10. Extract the square root of  $\frac{7}{5}$  to seven places of decimals.

11. Find the true discount, allowing the usual 3 days' grace, upon a bill for £603, drawn Oct. 4th at 4 months, and discounted Nov. 26th at  $2\frac{1}{2}$  per cent per annum.

12. Given that a metre is 39.37079 inches, prove that the difference between 5 miles and 8 kilometres is nearly 51 yards. (A kilometre is 1000 metres.)

## V.

### *College of Preceptors.*

*Professional Preliminary Examination. March, 1886.*

*(Second Class.)*

1. Find the sum, difference, product, and quotient of two dozen dozen and half-a-dozen dozen.

2. A gentleman left his daughter the contents of a writing table, in which were found 13 drawers, in each drawer 7 divisions, and in each division 3 purses, each purse containing £7 in gold, 14 crowns, 3 half-crowns, and 217 pennies. Find the value of the legacy.

3. Multiply 3 mls. 5 fur. 17 pls. 5 yds. 1 ft. 10 in. by 7; and 1574 hhds. 62 gals. 3 qts. 0 pt. 2 gills by 27. Reduce 23 ac. 1 rd. 27 po. 24 sq. yds. 6 sq. ft. 103 sq. in. to square inches.

4. What number added to  $9\frac{1}{2}$  will give  $12\frac{5}{6}$ ; and from what fraction must  $\frac{5}{18}$  be subtracted to leave exactly  $\frac{1}{2}$ ?

5. Find the values of

$$(i) \quad 5\frac{1}{2} - 7\frac{1}{6} + 4\frac{1}{4} + 3 - \frac{2}{3}; \quad (ii) \quad \left(3\frac{1}{2} \times 5\frac{1}{7}\right) \div \left(\frac{16}{5} \times 3\frac{3}{4}\right) + \frac{1}{2}$$

6. If 5 men or 7 women can do a piece of work in 37 days, in what time will 7 men and 5 women do a piece of work twice as great?

7. Find the cost of 3 tons 5 cwt. 27 lbs. 13 oz. at £4. 13s. 4d. per quarter.

8. If  $1\frac{3}{4}$  yard of silk cost 10s.  $11\frac{1}{4}$ d., what will be the cost of  $75\frac{1}{8}$  yards; and how many yards can be bought for £5?

9. Find the simple interest on, and the amount of, £240. 12s. 6d. at  $2\frac{1}{2}$  per cent. for  $8\frac{3}{4}$  years.

10. Arrange the figures 194678 in the six different ways in which 194 are the *first* three figures in different order, and also in the six different ways in which 678 are the *last* three figures in different order; and add the twelve arrangements together.

## VI.

*College of Preceptors.*

*Diploma Examination. Midsummer, 1886.*

1. Prove that a number is divisible by 8, if the number expressed by its last three figures is divisible by 8.

Find the L.C.M. of 3875, 1160, 17500, 3784.

2. Show that, if the numerator and denominator of a fraction be each multiplied by the same number, the value of the fraction is unaltered.

Arrange in order of magnitude the fractions :

$$\frac{3}{4}; \frac{5}{6}; \frac{7}{9}; 2\frac{1}{15} \div 2\frac{2}{5}; 4\frac{1}{7} \text{ of } \frac{\frac{1}{3}}{1 + \frac{1}{2} \frac{1}{5}}.$$

3. How is it evident that, in the reduction of a vulgar fraction to a decimal, if the decimal does not terminate, one or more figures of the quotient must recur?

Express as decimals,  $\frac{5}{7}$ ,  $\frac{5}{8}$ ,  $\frac{5}{9}$ ; and as vulgar fractions,  $\cdot\dot{6}$ ,  $\cdot0\dot{6}$ ,  $\cdot\dot{0}\dot{6}$ . Also give as a circulating decimal the sum of these three decimals.

4. Reduce 17 cwt. 2 qr. 7 lb. to the decimal of a ton.

What decimal fraction of 4 acres 3 roods 32 perches is equal to 1 acre 3 roods 8 perches?

5. Find the area of a room 19 ft. 4 in. long and 14 ft. 3 in. broad; and the cost of carpet for it, 2 ft. 9 in. wide, at 4s.  $1\frac{1}{2}d.$  per yard.

6. Explain what is meant by two quantities being inversely proportional.

If 35 men can do a piece of work in 12 days, working 8 hours a day, in how many days could 30 men do half the work, working 7 hours a day?

7. If 8 lbs. of coffee cost as much as 5 lbs. of tea, and 7 lbs. of coffee as much as 40 lbs. of sugar, what is the price of each when 1 lb. of tea, of coffee, and of sugar, together, cost 4s.  $7\frac{1}{2}d.$ ?

8. If a year's profits on a capital of £872,325 amount to £75,118. 17s. 6d., find to the nearest quarter the highest dividend that can be paid, and how much will be carried forward.

9. What is the true discount on £76. 15s. due eight months hence, at  $3\frac{1}{2}$  per cent.?

10. Of two watches, one loses 5 seconds and the other gains 4 seconds in 12 hours; they are both right at noon on a certain day, when will one be 5 minutes before the other, and what time will each then show?

## VII.

### *College of Preceptors.*

*Pupils' Examination. Christmas, 1886.*

*(First Class.)*

1. What weight remains after taking 15 parcels, weighing 3 qr. 13 lb. 12 oz. 9 dr. each, from a heap of 2 tons 14 lb.?

2. Two cog-wheels, one with 15 teeth, the other with 28 teeth, work together. If the former turns round 16 times in  $7\frac{1}{2}$  seconds, how many times will the latter turn round in 21 seconds?

3. How many allotments of 4 acres 2 roods 36 rods each may possibly be taken out of a stretch of land 56 miles long by  $20\frac{1}{4}$  miles?

4. *A*, *B*, and *C* play cricket. *A*'s runs are to *B*'s, and *B*'s runs are to *C*'s, as 3 : 2. They get altogether 342 runs. How many did each get?

5. (i) Multiply, and (ii) divide, 57·8234 by ·00045. Find what decimal 3 yd. 2 ft. 2 in. is of  $2\frac{1}{2}$  rods.

6. Obtain the cube of 10·01; and the square root of 66135·3171845, to 5 places of decimals.

7. Determine at what rate per cent. £3750 will increase to £4341. 1s. 10½*d.* in 3 years, (i) at simple interest, (ii) at compound interest; it being given that, *in this latter case*, the ratio of the amount to the principal is the cube of the ratio of the amount of £1 at the same rate in one year to £1.

8. Obtain the true discount on a bill for £4600, due  $2\frac{1}{2}$  years hence, at 8 per cent. per annum.

9. A reduction of 40 per cent. in the price of half-crown tea enables me to buy for my money 6 lbs. more than I could previously buy for a sovereign. What amount have I?

10. The length of a room is treble its breadth. The cost of flooring, at 7s. 6*d.* per sq. yard, is £28. 2s. 6*d.*, and that of painting the four walls, at 4½*d.* per sq. foot, is also £28. 2s. 6*d.* What is the height of the room?

## VIII.

*College of Preceptors.*

*Pupils' Examination. Christmas, 1886.*

*(Second Class.)*

1. How many sums of £4. 2s. 3¼*d.* each may be paid out of £300? What amount will remain?

2. Find (*by Practice*) the cost of 114 tons 3 cwt. 15 lb. 8 oz. of a mineral substance, at £844. 13s. 4*d.* per ton. Write the answer in words.

3. If 24 lbs. of spun flax make 69 yards of linen one yard wide, how many yards of linen 4 feet wide will 164 lbs. make?

4. Simplify (i)  $10\frac{16}{51} - \left(4\frac{3}{17} + 3\frac{2}{3}\right)$ ;

(ii)  $\frac{91}{122} \times \left(4\frac{1}{8} \text{ of } 6\frac{2}{7} + \frac{3}{14}\right) \div \left\{4\frac{1}{8} \text{ of } \left(6\frac{2}{7} + \frac{3}{14}\right)\right\}$ .

If in  $4\frac{2}{7}$  hours a train travels  $105\frac{4}{5}$  miles, what is its rate per hour?

5. Find the equivalent in decimals of the fractions  $\frac{29}{5}$ ,  $\frac{29}{5000}$ ,  $\frac{413}{672}$ , and  $\frac{547}{924}$ , the last two being known to recur within reasonable limits.

6. Obtain the square root of 17.453 to three decimal places. Obtain also the square of 17.453.

7. At what rate per cent. simple interest will £1560 increase in  $3\frac{1}{2}$  years to £1805. 14s.? What would be the *time*, supposing the *rate* to be 2 per cent.?

8. Obtain the compound interest on £8457. 14s. 6d. in  $2\frac{1}{4}$  years at  $1\frac{1}{4}$  per cent., *neglecting farthings throughout*.

9. A seven-foot strip along two adjacent sides of a rectangular garden forms a border for flowers. If the dimensions of the garden be 42 ft.  $\times$  34 ft., what is the exact proportion of the strip to the whole area?

## IX.

*College of Preceptors.*

*Pupils' Examination. Christmas, 1886.*

*(Third Class.)*

1. One ship contains 7928 cwt. of merchandise, a second contains 39254, and a third 20638. What is the difference between the contents of the first and second, the first and third, and the second and third?

2. Multiply the difference between 12 cwt. 3 qr. 17 lb. 10 oz. and 5 cwt. 2 qr. 23 lb. 11 oz. by 528. Divide the sum of the same two quantities by 324.

3. What is the cost of 168 barrels 15 gallons 3 quarts of beer, at 4s. 4d. per gallon? (36 gallons make 1 barrel.)

4. Find the value of  $\frac{3}{7}$  of £5. 18s. 5d., and explain the process you make use of.

5. Give the Highest Common Factor of 10395 and 16819; also the Lowest Common Multiple of 63, 12, 84, 14.

6. Arrange in order of magnitude the fractions  $\frac{2}{3}$ ,  $\frac{5}{6}$ ,  $\frac{4}{5}$ ,  $\frac{3}{4}$ ,  $\frac{13}{15}$ ,  $\frac{11}{12}$ .

7. Simplify the fractions:

$$(i) \left(\frac{5}{2} - \frac{2}{5}\right) \div \left(\frac{4}{3} - \frac{3}{4}\right); \quad (ii) \frac{\frac{1}{2} + \frac{1}{3} + \frac{1}{4}}{\frac{1}{2\frac{1}{2}} + \frac{1}{3\frac{1}{2}} + \frac{1}{4\frac{1}{2}}}$$

8. Reduce  $\frac{2}{9}$  of  $\frac{5}{13}$  of 19s. 6d. to the fraction of  $\frac{3}{5}$  of  $\frac{4}{17}$  of £1. 8s. 4d.

9. How many yards of carpet  $\frac{3}{4}$  yard wide will cover a room, the width of which is 16 feet and its length  $27\frac{1}{2}$  feet?

## X.

### *College of Preceptors.*

*Professional Preliminary Examination. September, 1886.*

*(First Class.)*

1. A gentleman divided £4. 18s. among 150 school-children, giving the girls a shilling each, and the boys sixpence: how many boys and girls were there?

2. If a sovereign weighs 5 dwt. 8 gr., what is the value of 106lb. 9 oz. 16 dwt. of the same metal?

3. Find (by Practice) the rent of 315 acres 3 roods 7 poles, at £1. 16s. 8d. per acre.

4. Simplify the expressions :

$$\frac{5}{8} \div \frac{2}{3} \text{ of } 3\frac{3}{4} \div \frac{1}{9} \text{ of } 1\frac{1}{4} \text{ of } 4\frac{1}{2}$$

$$\frac{3}{4} \div \frac{2}{3} + 3\frac{3}{4} \div \frac{5}{56} \text{ of } 1\frac{1}{8} \text{ of } 3\frac{1}{2}$$

5. Obtain the values of 2·25 of £3. 7s. 4d.;  $\frac{3}{4}$  of  $\frac{1}{3}$  of £6. 2s. 3d.; and reduce 2 cwt. 1 qr. 27 lb. to the decimal of 4 cwt. 1 qr. 20 lb.

6. Give the square of 2·403, and extract the square root of 235·6 and the cube root of 3·00415, each to three decimal places.

7. Calculate the present worth of a bill for £554. 17s. 11 $\frac{3}{4}$ d. drawn April 15th at 6 months, paid August 6th, at 3 $\frac{1}{2}$  per cent., the usual "days of grace" being allowed.

8. Find what sum of money, invested in railway stock paying 4 $\frac{1}{2}$  per £100 share, at a time when each share cost £97. 10s., will produce an annual income of £363. 16s.

9. How many tons of water are there in a reservoir 30 ft. 6 in. long, 16 ft. 6 in. wide, and 20 ft. deep (a cubic foot of water weighs 1000 ounces)?

10. When silk is sold at 19 francs 25 centimes the metre, find the corresponding price per yard in shillings and pence: supposing £1 = 25 fr. 20 cent., and 1 metre = 39·371 inches.

## XI.

*College of Preceptors.*

*Professional Preliminary Examination. September, 1886.*

*(Second Class.)*

1. Add together £15. 10s. 3 $\frac{1}{4}$ d., £5. 7s. 8 $\frac{1}{2}$ d., and 2s. 0 $\frac{1}{4}$ d.; and subtract from the result  $\frac{1}{3}$  of £16. 12s. 6d.

2. Multiply 3 tons 4 cwt. 1 qr. 17 lb. by 42; and reduce 847659014 inches to miles.

3. Find the value of a gold cup weighing 4 lb. 2 oz. 15 dwt. 7 gr., at £6. 10s. per oz.

4. How much was paid for painting a wall  $16\frac{1}{2}$  ft. long,  $12\frac{1}{4}$  ft. broad, at 3s. per square yard?

5. Add  $\frac{5}{18}$ ,  $\frac{7}{45}$ , 4,  $7\frac{7}{30}$ ; subtract  $3\frac{4}{45}$  from  $8\frac{1}{30}$ ; multiply  $9\frac{5}{11}$  by  $4\frac{1}{3}$ ; and divide  $72\frac{1}{2}$  by  $7\frac{1}{4}$ .

6. Reduce to decimals: (i)  $\frac{3}{8}$ ,  $\frac{7}{20}$ ,  $\frac{11}{125}$ ; (ii)  $\frac{3}{7}$ ,  $\frac{7}{12}$ ,  $\frac{11}{30}$ ; and state how you can tell by inspection which set of fractions will produce *finite* and which *recurring* decimals.

7. Extract the square root of 34225, or 557·196025.

8. Determine the amount of £312. 10s., after 7 years, at  $5\frac{1}{3}$  per cent. per annum.

9. At what rate per cent. will a sum treble itself at simple interest in 25 years?

## XII.

### *College of Preceptors.*

#### *Diploma Examination. Christmas, 1886.*

1. Define the *prime factors* of a number. Determine those of 282660 and 40299. Hence deduce the G.C.M. and L.C.M. of these numbers.

2. Simplify  $3 + \frac{1\frac{3}{8} + \frac{11}{12}}{2\frac{11}{15} - 1\frac{9}{20}}$  of  $4\frac{1}{12}$  of  $3\frac{3}{7}$ .

3. Reduce  $\frac{3}{800}$  and  $\frac{5}{28}$  to decimals, and  $\cdot 235\bar{4}$  to a vulgar fraction.

4. Write notes of a lesson on the conversion of decimals to their equivalent vulgar fractions, and the converse process.

5. A truck is loaded with 100 sacks; the sack itself in each case weighs 6 lb. 11 oz., and each sack contains 85 lb. of grain. What is the weight of the whole load in tons, cwts., qrs., lbs.?

6. If a family, by using 6 gas-burners 5 hours a day, pay £1. 5s. per quarter, when gas is at 5s. per 1000 cu. ft., what will a family, using 8 burners 3 hours a day, pay per quarter, when gas is at 3s. 9d. per 1000 cu. ft.?

7. A person has a certain sum with which he intends to pay three of his tradesmen, *A*, *B*, and *C*. He pays  $\frac{3}{5}$  of what he had to *A* and  $\frac{2}{5}$  of the remainder to *B*, and what he has left, which amounts to £75, to *C*. How much money does he pay in all?

8. A person borrows £100, and at the end of each year pays £25 to reduce the principal and to pay interest at 4 per cent. on the sum which has been standing against him through the year. How much will remain of the debt at the end of 3 years?

9. A person invests half his capital in the 3 per cents. at 99, and half in 4 per cents. at 120; which investment produces the larger income? Supposing his total income to be £490, what capital does he invest?

10. A watch, set on Friday at 9 p.m., gains 45 seconds in 12 hours; what time does it show on the next Monday at 3 p.m.?

### XIII.

*London University.*

*Matriculation. June, 1884.*

1. Multiply 1.231056 by .81231056 correctly to seven places of decimals.

2. Calculate the numerical value of  $\frac{1}{\sqrt{8}}$  to seven places of decimals.

3. Find the difference between simple and compound interest on £7466. 13s. 4d. for three years at  $3\frac{3}{4}$  per cent.

4. A sum of £1640 is borrowed, to be paid back in two years by two equal annual payments, allowing 5 per cent. compound interest. Find the annual payment.

10. A person finds he can obtain £5 more per annum by investing in the  $3\frac{1}{2}$  per cents at 96 than in the 3 per cents. at 88; how much has he to invest?

[Questions 5 to 9 were in Algebra.]

## XIV.

*London University.**Matriculation. Jan. 1885.*

1. Express  $\frac{2}{3} + \frac{4}{5} - \frac{3}{4}$  as a fractional part of  $\frac{2}{9} + \frac{3}{5} - \frac{2}{7}$ , and reduce  $\cdot 06$  of a guinea to the decimal of a pound.

2. The circumference of the earth is 40,000,000 metres, the length of a metre being 39·37079 inches; calculate the diameter of the earth in miles, assuming the ratio of the circumference of a circle to its diameter to be 355 : 113.

3. If  $x = \frac{3 \cdot 14159}{3600}$  find the values of  $x^2$  and  $x^3$  to six places of decimals.

4. Find the price of 659 bales of cotton, each weighing 1 cwt. 1 qr. 21 lbs. at £2. 3s. 1½d. per cwt.

5. Find the square root of  $34967\frac{2}{11}$  to four places of decimals.

7. *A* and *B* together can perform a piece of work in 24 hours, *A* and *C* in 30, and *B* and *C* in 40 hours: in what time will each be able to perform it when working separately?

[Questions 6, 8, 9, 10 were in Algebra.]

## XV.

*London University.**Matriculation. June, 1885.*

1. A dealer buys coffee at £5. 15s. per cwt. and chicory at £2. 12s. 6d. per cwt., and mixes them in the proportion of four parts of chicory to seven of coffee. Find at what price per cwt. he should sell the mixture so as to gain 20 per cent. on his outlay.

2. Express

$\frac{1}{2} + \frac{1}{2 \cdot 4} + \frac{1}{2 \cdot 4 \cdot 6} + \frac{1}{2 \cdot 4 \cdot 6 \cdot 8} + \frac{1}{2 \cdot 4 \cdot 6 \cdot 8 \cdot 10} + \frac{1}{2 \cdot 4 \cdot 6 \cdot 8 \cdot 10 \cdot 12}$   
as a decimal to ten places.

3. Find, to five places of decimals, the value of  $\frac{\sqrt{3} - \sqrt{5}}{\sqrt{5} + \sqrt{3}}$ .

10. If 310 men can dig a trench of 11 feet broad, 6 feet deep and 155 yards long in half-an-hour, find what length of trench 10 feet broad and 7 feet deep 2000 men can dig in 6 hours.

[Questions 4 to 9 were in Algebra.]

## XVI.

*London University.*

*Matriculation. Jan. 1886.*

1. Divide the cube of 1.236068 by 2.36068 correctly to five places of decimals.

2. Find the value of  $\sqrt{\frac{7}{5}}$  to seven places of decimals.

3. Given that a metre is 39.37079 inches, prove that the difference between 5 miles and 8 kilometres is nearly 51 yards. [A kilometre is 1000 metres.]

4. A bill for £603 drawn October 4 at four months is discounted November 26 at  $2\frac{1}{2}$  per cent. per annum. Find the true discount, allowing the usual three days' grace.

[Questions 5 to 10 were in Algebra.]

## XVII.

*London University.*

*Matriculation. June, 1886.*

1. Multiply 3.73205 by .26795 correctly to 5 places of decimals.

2. Calculate, without making use of any rule, the value of .279 in the form of a vulgar fraction.

3. Calculate  $\frac{1}{\sqrt{.4}}$  correctly to four places of decimals.

4. A man lends £114. 11s. 8d. for a year at 3 per cent.: how much should he receive at the end of the year? If he should lend the whole of the sum received at the end of this year for the same period at the same rate per cent., to how much would he be entitled at the close of this second year?

5. Simplify

$$\frac{\left(\frac{1}{2} + \frac{1}{5}\right)\left(\frac{1}{2} + \frac{1}{6}\right)}{\left(\frac{1}{2} - \frac{1}{3}\right)\left(\frac{1}{2} - \frac{1}{4}\right)} + \frac{\left(\frac{1}{3} + \frac{1}{5}\right)\left(\frac{1}{3} + \frac{1}{6}\right)}{\left(\frac{1}{3} - \frac{1}{2}\right)\left(\frac{1}{3} - \frac{1}{4}\right)} + \frac{\left(\frac{1}{4} + \frac{1}{5}\right)\left(\frac{1}{4} + \frac{1}{6}\right)}{\left(\frac{1}{4} - \frac{1}{2}\right)\left(\frac{1}{4} - \frac{1}{3}\right)}.$$

8. A piece of work is done by three men  $A$ ,  $B$ , and  $C$  in 5 days in the following manner:  $A$  works the whole time,  $B$  only on the first and second days,  $C$  only on the third, fourth, and fifth days. The work might also have been done by  $B$  and  $C$  working together for 6 days without the assistance of  $A$ . If  $B$  and  $C$  working together for 2 days can do as much work as  $A$  can do alone in 3 days, find how long it would take  $A$ ,  $B$ , and  $C$  each to do the work separately.

9. An article is first sold at a profit of 10 per cent.; the purchaser then again sells it for 4s. 7d., and his gain is 15 per cent. of the price at which he sells it. How much did the article originally cost?

[Questions 6, 7, and 10 were in Algebra.]

## XVIII.

*London University.*

*Matriculation. Jan. 1887.*

$$1. \text{ Simplify } \frac{\left(\frac{2}{3} - \frac{2}{11} + \frac{16}{21}\right) \div \left(2 + \frac{1}{2 + \frac{1}{2}}\right)}{\left(\frac{3}{77} + \frac{2}{33} - \frac{1}{21}\right) \times \left(3 - \frac{1}{3 - \frac{1}{3}}\right)}.$$

2. Find the square root of .121 to five places of decimals.

3. Calculate the value of  $\sqrt{\frac{(\cdot78) \times (\cdot00004)}{(\cdot013) \times (\cdot015)}}$ .

7. A person has a certain amount of 4 per cent. stock. He sells it at  $117\frac{1}{3}$ , and invests half the proceeds in 2 per cent. stock at 96, and the rest in 3 per cent. stock at 99. He then finds that his annual income is reduced by £20. What amount of the original stock had he?

[Questions 4, 5, 6, 8, 9, 10 were in Algebra.]

### XIX.

*Oxford Local Examinations. Junior Candidates.*

*June, 1884.*

1. Write a thousand and thirty-three millions seventy thousand two hundred and one in figures; and express in words 909009909.

2. A pit from which 38476 cubic yards of soil had been extracted has had thrown into it 10000 loads of rubbish each containing 101 cubic feet. How many more cubic feet will it hold?

3. Divide 3986544 by 2116; and also 56 tons 6 cwt. 1 qr. 13 lbs. by 321.

4. Reduce 17 miles 3 furlongs 19 poles 4 yards to inches.

5. Simplify as much as possible  $\frac{5\frac{2}{3} - 2\frac{3}{5}}{4\frac{5}{8} \text{ of } \frac{2}{185}}$ ; and multiply

the sum of  $\cdot0083$  and  $\cdot8003$  by  $8\cdot003$ .

6. Express 25 acres as the fraction of  $1\frac{1}{2}$  square miles; and find the value of  $\cdot06875$  of £20.

7. If 27 horses can be bought for £2400, how many can be bought for £1333. 6s. 8d.?

8. Two rooms contain equal quantities of air. The area of the floor of one of them is 340 square feet and its height 12 feet. Find the area of the floor of the second, whose height is 17 feet.

9. A rectangular court-yard is 100 feet long and 60 broad. Two paths cross it at right angles, one from end to end and the other from side to side. Each of these is 5 feet wide. Find the cost of laying down the remaining area with turf at 6*d.* per square yard.

10. At what rate is £84. 14*s.* the simple interest on £2400 for  $1\frac{3}{4}$  years?

11. If 8 men can reap 16 acres in 3 days working 10 hours a day, in how many days can 3 men reap 64 acres working  $10\frac{2}{3}$  hours a day?

12. A property, consisting of 900 acres of land and an amount of stock of exactly the same value, is left to be divided equally among two persons. The first of these persons receives as his share 700 acres and stock to the value of £15000. What is the land worth per acre?

## XX.

*Oxford Local Examinations. Junior Candidates.*

*July, 1885.*

1. From the sum of six hundred millions fifty thousand and sixty, and twenty-three thousand and two, subtract the sum of five hundred and two millions five hundred and twenty thousand and nine, and two hundred thousand and one. Express the result in words.

2. Multiply 234125 by 6804, and divide 310 miles 3 fur. 32 po. 5 yds. 2 ft. by 75.

3. Find the number of tons, cwt., &c. in 42874648 drams.

4. From the product of  $\frac{2}{3}$ ,  $4\frac{1}{4}$ ,  $3\frac{2}{17}$ , subtract the difference of  $2\frac{3}{4}$  and  $5\frac{1}{12}$ .

Express  $\cdot30i\dot{0}$  as a vulgar fraction in its lowest terms.

5. Find the value of  $\cdot123725$  of a ton, and express the result as the decimal of 1 cwt.

6. If a train run 49 miles in 1 hour and 10 minutes; how long will it take to run 770 yards?

7. The taxes paid by a certain householder amount to £11. 15s. 7½d. at 3s. 7½d. in the pound. What is the rent of his house?

8. In what time will £156. 13s. 4d. amount to £166. 18s. 11½d. at 3½ per cent. per annum, simple interest?

9. A grazier sold 36 sheep for £74. 5s. and made thereby a profit of 10 per cent. What did he give for each sheep?

10. The external dimensions of a box (with a lid) are as follows: length 2 feet, breadth 1½ feet, height 1 foot. How many cubic inches of air are there in it, if the walls of the box are ½ inches thick?

11. If the wages of 11 labourers for 15 weeks be £103. 2s. 6d., in what time will the wages of 13 labourers amount to £170. 12s. 6d. at the same rate per week?

12. A man invests £5000 in the 3½ per cents. when they are at 73½: what is his income?

## XXI.

*Oxford Local Examinations. Junior Candidates.*

*June, 1886.*

1. Divide 3595521645 by 50709; and express the answer in words.

2. Multiply 7 miles 6 furlongs 22 poles 4 yards by 27.

3. If a sovereign weighs 5 dwts. 3 grains, and a shilling weighs 3 dwts. 15 grains, how much less will 48 sovereigns weigh than the equal value in shillings?

4. Reduce (1)  $\cdot 708\bar{3}$  to a vulgar fraction;

(2)  $1\frac{1}{25} \times 3\frac{5}{6} \div 6\frac{3}{11}$  to a decimal.

5. Find the value of  $\cdot 0053125$  of £20; and reduce £1. 17s. 1½d. to the fraction of £22. 5s. 6d.

6. If 14 cwt. 8 lbs. of steel cost £54. 3s. 6d., what will be the cost of 17 cwt. 16 lbs.?

7. If the interest on £650 for 5 months is £12. 3s. 9d., what is the rate per cent.?

8. Find by practice the cost of 1297 trucks of coals at £4. 17s. 11½d. per truck.

9. What will be the cost of painting and decorating the walls of a room 22 ft. 6 in. long, 17 ft. 3 in. wide, and 15 ft. high, at 3s. 6d. per square yard?

10. Find the square root of 1166·2225.

11. If a person invests £1496. 5s. in three per cent. stock at 99¾, what income will he receive? And, if he afterwards sells the stock at 100⅘, what will he get for it?

12. A farmer bought 4 horses and 7 cows for £238, the prices of a horse and a cow being as 5 : 2; how much did he give for each?

## XXII.

*Oxford Local Examinations. Junior Candidates.*

*July, 1887.*

1. Divide seven hundred and ninety-nine millions four hundred and thirty-eight thousand two hundred and ninety-nine by eleven hundred and eighty-eight; and give the quotient and remainder in words.

2. How many times is 11¼d. contained in £28. 2s. 6d.?

3. Simplify  $\frac{4\frac{1}{5} - \left(\frac{2}{3} \text{ of } \frac{5}{6}\right)}{1\frac{2}{3} + 1\frac{3}{7} - \frac{2}{5}} \times \frac{1}{\frac{1}{\frac{1}{2} + \frac{1}{3} + \frac{\frac{1}{6}}{\frac{3}{4} - \frac{1}{3}}}}$ .

4. If 76 articles cost £25. 0s. 4d., how much will 46 cost?

5. How many trucks are there in a coal train which carries 101½ tons, if each truck holds 6 tons 6 cwt. 3½ qrs.?

6. (1) Multiply ·0001234 by 512·3 and by ·05123;

(2) Find the value of 2·309 of £1. 7s. 6d.

7. Find by Practice the value of 39 cwt. 3 qrs. 26 lbs. at £4. 16s. 10d. per cwt.

8. By selling a carriage for £29. 18s. 9d. a man lost one-sixth of what it cost him. How much would he have lost or gained by selling it for £36?

9. If 7 men and 2 women earn £51 in 8 weeks, and 4 men and 2 women earn £46. 10s. in 12 weeks, what are the weekly wages of a man and woman?

10. A floor is 27·3 ft. long and 20·16 ft. broad: what will be the cost of covering it with matting 2·4 ft. broad at 2s. 6d. a yard?

11. At what rate per cent., simple interest, will £514. 7s. 6d. amount to £694. 8s. 1½d. in 7½ years?

12. A cistern can be emptied by 3 pipes in 3 hours; one pipe alone would empty it in 6 hours, another in 9 hours: how long would the third pipe take?

### XXIII.

*Oxford Local Examinations. Senior Candidates.*

*June, 1886.*

1. In a court-yard 67 ft. 6 in. long and 42 ft. 9 in. wide there is a foot-way, 5 ft. 6 in. wide, the whole length of the yard. What is the cost of paving the whole, the price per square yard for the foot-way being 3s. 6d., and for the remainder 3s.?

2. (1) Simplify  $\frac{\frac{1}{6} \div \frac{3}{11}}{\frac{5}{7} - \frac{2}{3}} - \frac{2\frac{1}{2} - 1\frac{5}{6}}{7 \times \frac{16}{21} \div \frac{8}{3}}$ .

(2) What fraction of a cwt. is 1 qr. 22 lbs. 14 oz. 8⅓ dr.?

3. Find to six places of decimals

(1) the value of  $7.653478 \times .03576$ ;

(2) what decimal a day is of a year, when the year is taken at  $365\frac{1}{4}$  days.

4. (1) Reduce 2 qrs. 5 bushels 2 pecks 1 gal. 3 qts. 1 pint to the decimal of a load.

(2) Find the value in cubic feet and inches of  $.226851$  of a cubic yard.

5. Find the value of 10 tons 13 cwt. 2 qrs. 18 lbs. at  $\text{£}2.6s.8d.$  per ton.

6. Of three pipes *A*, *B* and *C*, *A* fills a cubic inch in a second, *B* a cubic foot in a minute, *C* a cubic yard in an hour; if all were running together, in what time would they fill 1069 cubic inches?

7. What will  $\text{£}1000$  amount to, in 3 years, at 5 per cent. per annum compound interest?

8. What is the present worth of a bill for  $\text{£}151.10s.$ , due in 80 days, the rate of interest being  $4\frac{9}{8}$  per cent. per year of 365 days?

9. I invest  $\text{£}2820$  in Italian Five per Cents. at 94, sell the stock again at 95, and reinvest the proceeds in Spanish Four per Cents. at 57. If I receive a quarter's dividend on the Spanish stock, and afterwards sell it at 58, what sum shall I realize by the dividends and sale together?

10. If 48 gallons of spirit at 12s. per gallon,  $2\frac{3}{4}$  gallons at 10s. 6d., and  $19\frac{1}{2}$  gallons at 1s. 4d., be mixed with  $19\frac{3}{8}$  gallons of water; and the mixture sold at 7s.  $10\frac{1}{2}d.$  per gallon; what is the gain per cent.?

11. Find to three places of decimals the square root of  $8\frac{15}{49}$ .

12. If  $\text{£}1$  is equivalent to 25 francs, 36 ducats to 375 francs, and 19 ducats to 40 roubles, find how many roubles are equivalent to  $\text{£}95$ .

## XXIV.

*Oxford Local Examinations. Senior Candidates.*

*July, 1887.*

1. Find the present value of £1919. 5s. 11½*d.* due 2 years and 7 months hence, simple interest being reckoned at 3 per cent.

2. If £235, after being lent for 4 years at simple interest, amounts to £267. 18*s.*, find the rate at which interest is charged.

3. Divide .000324 by .018, .0000018, and 1800.

4. Reduce 33 yards to the decimal of a mile.

5. Simplify the expression

$$\frac{\frac{5}{14} - \frac{3}{7} \text{ of } \frac{1}{2}}{\frac{5}{16} + \frac{7}{12} \text{ of } 3\frac{1}{4} - \left( \frac{7}{8} \text{ of } \frac{37}{21} - \frac{1}{3} \right)} \div \frac{\frac{1}{3} \text{ of } \frac{1}{2} + \frac{3}{2} \text{ of } 5}{9\frac{1}{3} - 1\frac{2}{3}}.$$

6. Reduce .03042 of 3 tons 15 cwt. 75 lbs. to ounces and the decimal of an ounce.

7. Find the value of 3.6 of .954 of .428571 of 18*s.* 6*d.*

8. By selling a horse for £85 a man lost 7½ per cent.; find what would have been his gain or loss per cent. if it had been sold for £96. 10*s.*

9. The circumference of a carriage-wheel is 2 yds. 2 ft. 2 in.; how many times will it revolve during a journey of 27 miles, 578 yds. 2 ft. 10 in.?

10. How many days of 10 hours each would 60 men take to perform a piece of work which 45 men can do in 30 days of 12 hours each?

11. A bankrupt's liabilities are £6235. 10*s.*, and he pays his creditors 5*s.* 6*d.* in the pound. Find by Practice the amount of his assets.

12. If 3 kilometres are as much under 2 miles as 5 kilometres are over 3 miles, what is the length of a kilometre?

13. Find the square root of  $37\frac{212}{841}$ .

## XXV.

*Cambridge Local Examinations. Junior Students.*

*December, 1882.*

1. A certain star is five millions nine hundred and ninety-five thousand nine hundred and forty-four times as far from the Earth as is the Sun. State *in words* the number of seconds which light, travelling one hundred and eighty-six thousand miles per second, will occupy in coming from that star to the Earth, if the Earth is distant ninety-three millions of miles from the Sun; and express your answer in years, supposing a year to equal 365 days 6 hours.

2. Divide £9652. 6s. 0d. by 96 (using factors of 96 as successive divisors); and 1 a. 2 r. 8 p. 11 sq. yds. 2 sq. ft. 108 sq. in. by 367.

3. The cost of 5 cwt. 2 qrs. 14 lbs. of coffee is £56. 13s. 9d. If the whole is sold at 1s. 11½d. per lb., what is the total gain or loss?

4. If it cost as much to feed 3 men as to feed 4 boys, and for 3 boys the cost is found to be 19s. 2½d. per week, how much per week will it be for 51 men?

5. Find by Practice the charge for fencing 2 m. 3 f. 170 yds. 1 ft. 6 in. of road at £671 per mile.

6. Subtract  $1\frac{19}{39}$  from  $2\frac{7}{130}$ ; and reduce the result to its lowest terms.

Simplify 
$$\frac{3\frac{7}{8} - 4\frac{1}{3} + 2\frac{1}{12}}{9\frac{1}{36} - 7\frac{19}{27}}$$

7. Subtract  $\frac{15}{16}$  of £16. 2s. 4d. from 0.125 of £1626. 15s.; and find by what decimal the result must be multiplied to produce £1. 6s. 1½d.

8. If it costs £49. 14s. 6d. to decorate a wall-space measuring 69 ft. 4 in. by 6 ft. 9 in., what will it cost for one measuring 22½ yds. by 3½ yds., the style of decoration used in the second case being half as expensive again as in the first case?

9. Shew that, at 5 per cent., the interest on £650 for three months is equal to the true discount on £495. 12s. 6d. due in four months' time.

10. What income would be obtained by investing

£12002. 12s. 4½d.

in 3 per cent. stock at 93?

11. Find the square root of 549081 and of  $5\frac{4}{9}$ .

A man after a tour in Switzerland found that he had spent every day half as many shillings as the total number of days he had been from home. His tour cost £57. 12s. How many days did it occupy?

12. Two settlers in New Zealand own adjoining farms of 3000 and 5000 acres respectively. They unite their farms, taking at the same time an additional partner, who pays them £8000, on the understanding that a third share of the land shall in future belong to each. How is the £8000 to be divided between the original owners?

## XXVI.

*Cambridge Local Examinations. Junior Students.*

*December, 1883.*

1. The population of the United Kingdom at the last census was thirty-five millions two hundred and seventy-eight thousand nine hundred and ninety-nine. There were seven hundred and eighty-nine thousand and one more women than men. How many were there of each sex? Write the answer in words.

2. The interest of the National Debt is 18s. 9d. per second. How much is that for a year of 365 days?

3. Two horses and a carriage cost together £250, one of the horses and the carriage cost £181. 13s. 7d., the other horse and the carriage cost £155. 6s. 5d. What was the separate cost of each of the three?

4. If 10 sheep or 15 lambs can eat 40 bushels of turnips in 7 days, how long will it take 6 sheep and 18 lambs to eat 36 bushels?

5. Find by Practice the cost of turning 453 a. 3 r. 15 p. of arable land into pasturage at £9. 17s. 4d. per acre.

6. Subtract  $\left(3\frac{5}{7} - 2\frac{26}{35}\right) \times \frac{17}{3}$  from  $78\frac{1}{7} + 23\frac{4}{21}$ .

One-twelfth of the weight of a gold coin is alloy of no value. If some sovereigns were coined of pure gold, how many of our present sovereigns would be equal in value to 143 of the new ones?

7. Simplify without converting the decimals into vulgar fractions

$$\frac{.00281 \times .0625}{1.405}$$

Extract the square root of 2.89. Extract the square root also of 28.9, correctly to 3 places of decimals.

8. Find the true discount on £328. 13s. 5d. due three months hence at 4 per cent. per annum.

9. What sum must be invested in 4 per cent. Spanish Stock at 63½ to give an income of £340. 4s. 8d.?

N.B. Brokerage not to be reckoned.

10. An Indian officer, whose annual pay was estimated in rupees, lost £41. 12s. 6d. in one year by a fall in the value of the rupee from 1s. 11½d. to 1s. 10¼d.; what was his salary, estimated in rupees?

11. A warehouse consists of seven floors; the rent of each floor is .875 times that of the floor below; the rent of the middle floor is £120. 1s.; compare the rents of the highest and lowest floors, and find that of the lowest.

12. The income tax is reduced from 10½d. to 5d. in the pound, but a man's gross receipts are at the same time reduced by 10 per cent. owing to the stoppage of a mine. Find by what percentage his net income is altered.

## XXVII.

*Cambridge Local Examinations. Junior Students*

*December, 1884.*

1. The area of the British Colonies is eight millions eight hundred and sixty-nine thousand and ninety-six square miles, and the population is two hundred and ninety-two millions six hundred and eighty thousand one hundred and sixty-eight. How many people are there to the square mile?

How much would a tax of  $2\frac{1}{2}d.$  per head on the whole population amount to in pounds, shillings, and pence? Write the answer in words.

2. A train is travelling at the rate of 35 miles an hour. How many feet does it travel in a second?

3. The live stock on a farm consists of a certain number of horses worth 60 guineas each, an equal number of pigs worth £2. 10s. each, 3 times as many cows worth £18. 10s. each, and 15 times as many sheep worth £1. 15s. each. The whole value of the live stock is £1030. 15s. How many are there of each kind?

4. A farmer has 1134 sheep and 630 lambs. He forms them into flocks, keeping sheep and lambs separate, and having the same number of animals in each flock. If these flocks are as large as possible, how many are there in each?

5. Divide  $7\frac{1}{5} \times 5\frac{1}{7}$  by  $5\frac{1}{3} \times 3\frac{1}{5}$ .

$$\frac{7\frac{1}{5} \times 5\frac{1}{7}}{5\frac{1}{3} \times 3\frac{1}{5}}$$

A man leaves by will £5000 to his wife, and the remainder to be equally divided among his four children. It is found that each of his children has one-seventh of his whole property. How much had he?

6. Simplify without converting the decimals into vulgar fractions

$$\frac{.0038425 - .00183}{.035}$$

Find the value of  $.0625$  of a guinea. Find the square root of  $1383.0961$ ; and of  $2\frac{23}{49}$ .

7. Find by Practice the cost of an iron bridge weighing 216 tons 12 cwts. 2 qrs. at £32. 17s. 2d. per ton.

8. The true discount on a certain sum due  $2\frac{1}{2}$  years hence at 3 per cent. per annum is £17. 14s. 6d. What is the sum?

9. The Chancellor of the Exchequer proposes to give £102 Stock paying interest at  $2\frac{3}{4}$  per cent., or £108 Stock paying  $2\frac{1}{2}$  per cent., in exchange for £100 of the present 3 per cent. Stock. Find the loss of income per cent. which would be incurred by accepting these offers respectively; and shew that the losses are in the ratio of 13 to 20.

10. A merchant buys 540 oranges at Seville for 6s. 8d.: the cost of packing is  $7\frac{1}{2}$  per cent. additional, and the cost of carriage is a penny more than  $60\cdot75$  times the original cost of an orange. If the oranges are then retailed at 5 for 2d., find the profit on 100 oranges.

11. The area of each of the 64 squares of a chess-board is  $4\cdot2025$  inches, and the outer rim of the board is  $\cdot3$  of an inch wide: find the length of a side of the board.

12. One clerk has  $24\cdot42857\bar{1}$  and a second clerk has  $38\frac{4}{7}$  sheets to engross: they call in a third clerk and agree to divide the work equally among the three, and to pay the third clerk at the rate of  $\cdot24305$  shillings per sheet: how much will he receive from each of them?

## XXVIII.

*Cambridge Local Examinations. Junior Students.*

*December, 1885.*

1. Add together ninety-nine millions; nine thousand and ten; seventy thousand and eighty; eight hundred thousand and nine; six hundred and eighty thousand and twenty-one. State in words by how much the sum falls short of two hundred millions.

2. Multiply £1. 18s.  $9\frac{1}{2}$ d. by 3008; and 3 qrs. 0 lb. 4 oz. by 134.

3. How many miles, furlongs, poles, &c. are there in 198247 inches?

4. Find by Practice the cost of 12 cwt. 3 qrs. 12 lbs. at £1. 10s. 4d. per cwt.

5. Find the sum of £3  $\frac{43}{96}$  and  $\left(9\frac{1}{12} - 2\frac{7}{8}\right)$  of 5s.

$$\text{Multiply } \frac{3\frac{1}{15} - 4\frac{3}{20} + 2\frac{1}{12}}{3\frac{1}{25} - 2\frac{1}{10}} \text{ by } \frac{3\frac{2}{15}}{\frac{2}{3} + \frac{3}{8} - \frac{5}{48}}.$$

6. Divide .20705 by .0101.

Subtract from 2 cwt. the sum of .3125 of 6 cwt. and .032 of 3 cwt. 2 qrs. 14 lbs. 4 oz.

7. If  $1002\frac{7}{8}$  cubic yds. of earth are carted  $3\frac{5}{7}$  miles for £70, how far should 181 cubic yds. 648 cubic inches be carted for the same sum?

8. Find the simple interest for  $2\frac{1}{4}$  years at  $3\frac{1}{4}$  per cent. on £481. 5s.

9. A man has £2000 of a 3 per cent. stock, which he sells out at 90, and then invests £1000 of the proceeds in 5 per cents. at 125. What rate of interest must he get for the remainder in order that his income may be unaltered? (Brokerage not to be reckoned.)

10. A sum of money is to be divided amongst 11 men and 18 boys, and 5 men are to receive as much as 9 boys. When 3 men and 3 boys have received their shares, what fraction of the whole sum will remain?

11. *A* works for 6 days at the rate of 8 hours per day; *B* works for 5 hours on the first day and on each of the five subsequent days one hour longer than on the preceding day: *A* does as much in 4 hours as *B* does in 5 hours. If the total sum paid to *A* and *B* as wages for the week be £2. 2s., how much should each receive?

12. A journey of 560 miles was made by rail, steamer and coach. The distance by coach was one-fourth, and the distance by sea three-fourths of that by rail. The fare per mile by coach was double, and by sea four-fifths of that by rail. What was the expense of the whole journey, railway fare being  $1\cdot571428d.$  per mile?

**XXIX.**

*Cambridge Local Examinations. Junior Students.*

*December, 1886.*

1. There are 57 boxes of rice each containing eight hundred and nine thousand three hundred and nine grains, and 76 other boxes each containing seven hundred and nineteen thousand two hundred and ninety-four grains : write *in words* how many grains of rice there are altogether.

2. How many ounces are there in thirteen times 1 ton 2 cwt. 11 lbs. ; and how many inches in 1 mile 2 furlongs 35 poles ?

3. What is the whole cost of 5 pairs of gloves at 2s. 11½*d.* a pair, 24 yds. of muslin at 1s. 9½*d.* a yard, 17½ yds. of ribbon at 8½*d.* a yard, and 35 yards of flannel at 1s. 7¼*d.* a yard ?

4. Find by Practice the cost of warming a building for 11 days 17 hours 28 minutes, if the cost is £4. 10s. per day.

5. Subtract  $4\frac{33}{35}$  from  $\frac{1}{6} + 2\frac{1}{7} + 13\frac{3}{10} + \frac{4}{21}$ .

6. Simplify

$\frac{1664}{1408}$  of  $\left\{ \frac{7}{10}$  of £3  $\frac{3}{14}$  + 6  $\frac{2}{3}$  of £3. 0s. 9*d.* - 4  $\frac{13}{31}$  of £3. 2s.  $\left. \right\}$ .

7. Multiply .004 by 32.4, and divide the product by 6.4. Express as a vulgar fraction the product of .27 and .916.

8. If I pay £2. 7s. 8¼*d.* as Income Tax on a rental of £71. 10s. 7½*d.*, what should I pay on a rental of £510. 15s. ?

9. Find the Compound Interest on £4500 for 2 years at 4½ per cent. per annum.

10. *C* does half as much in a day as *A* and *B* can do together, and *B* does half as much again as *A*. If all three working together can mow 20 acres of barley in 16 days, how long would each, working by himself, take to mow 5 acres ?

11. How much 3 per cent. stock sold at 92½ will produce £3700 ? If this sum of £3700 be then invested in Railway Stock at 115½, what percentage must this stock pay in order that the same income may be received as from the original investment ? (No brokerage is to be reckoned.)

12. A rectangular field which is twice as long as it is wide costs 1.0138s. per square yard of turf. If the whole cost is £191. 17s. 0¾*d.*, find the lengths of the sides of the field.

## XXX.

*Cambridge Local Examinations. Junior Students.*

*December, 1887.*

1. If 2948 bricks are used per yard to build a tunnel which is 6285 yards long; and 2175 bricks per yard to build another tunnel which is 6082 yards long: state *in words* how many more are used for the one tunnel than for the other.

2. How many payments of 1*s.* 11½*d.* amount to £89. 2*s.* 6¼*d.*; and how many plots each containing 2 roods 16 poles 8 sq. yds. are there in 10 acres 36 poles 15 sq. yds.?

3. What did the meat cost, at £4. 1*s.* 8*d.* per cwt., for a Jubilee feast for 100 men, 108 women, and 120 boys, the gross weight supplied for each man being 1½ lbs., and for 2 men as much as for 3 boys or 4 women?

4. Simplify  $3\frac{10}{11} + 5\frac{7}{15} - 2\frac{9}{22} - 4\frac{9}{10}$ .

Find the value of  $\frac{5}{7 - \frac{9}{3 - \frac{3}{4}}} + \frac{5}{16 - \frac{11}{2 - \frac{1}{6}}}$ .

5. A man runs  $4\frac{7}{5}$  times round a course  $930\frac{1}{4}$  yards long. What fraction of 3 miles  $301\frac{1}{2}$  yards does he run?

6. Find by Practice the cost of a fence 3 furlongs 11 poles  $3\frac{1}{4}$  yards long, at £183. 6*s.* 8*d.* per mile.

7. Divide 22·7088 by 3800.

Express as a circulator the sum of ·4348 and ·4554.

8. Find the value of ·8125 of 2 tons 4 cwt.; and the difference between 3·0693 of 8*s.* 5*d.* and £·6416.

9. If 6 compositors in 16 days of  $10\frac{1}{2}$  hours each can set in type 720 pages, each of 60 lines with 40 letters in a line; in how many days of 7 hours each will 9 compositors set 960 pages, each of 45 lines with 50 letters in a line?

10. What will £3255. 4*s.* 2*d.* amount to in a year and a half if put out at Compound Interest at 8 per cent. per annum, the interest being added at the end of each half year?

11. A grocer buys 15 lbs. of tea; he sells 8 lbs. at 2s. 7½*d.* per lb., and the rest at 2s. 9*d.* per lb.; and finds that he has made 15 per cent. profit. What rate per cent. profit would he have made if he had sold it all at 2s. 9¼*d.* per lb.?

12. A person invests £2362. 10s. 0*d.* in 3 per cent. Consols, which he sells when they have risen  $\frac{5}{8}$  per cent., thereby gaining 15 guineas. At what price did he buy them?

### XXXI.

*Cambridge Local Examinations. Senior Students.*

*December, 1886.*

1. How many rings, each weighing 4 dwts. 18 grs., can a goldsmith make from a mixture of 1 lb. 10 oz. 1 dwt. 18 grs. of pure gold with 7 oz. 7 dwts. 6 grs. of alloy?

2. Reduce 56248 inches to furlongs, yards, feet and inches.

3. Simplify

$$(1) \frac{39}{39 - \frac{1}{4\frac{1}{3}}} - \frac{40}{40 - \frac{1}{4\frac{3}{4}}} \quad (2) \frac{(\cdot 00185)^2}{(18\cdot 5)^2}.$$

4. Subtract 378 of 1s. 6½*d.* from 378 of 2s. 9*d.*

5. In a book on Arithmetic an example was printed thus:

$$\text{“Add together } \frac{1}{14\frac{2}{3}}, \frac{1}{19\frac{1}{4}}, \frac{1}{13\frac{3}{4}} \text{”}$$

the denominator of one fraction being accidentally omitted. The answer given at the end of the book was  $\frac{11}{28}$ : required the missing denominator.

6. Find by Practice the cost of 3 tons 11 cwt. 3 qrs. 10½ lbs. of iron wire at £8. 6s. 8*d.* per ton.

7. If the cost of provisioning a gunboat carrying 84 men be £598. 10s. when the ship is at sea for 95 days, what will it cost to provision for 33 days a ship carrying a crew of 110 men?

8. A bath can be filled by the cold water pipe in 9 minutes, and by the hot water pipe in  $11\frac{1}{4}$  minutes. A person leaves the bath room after turning on both pipes simultaneously, and returns at the moment when the bath should be full. Finding however that the waste-pipe has been open, he now closes it. In  $3\frac{3}{4}$  minutes more the bath is full. In what time would the waste-pipe empty it?

9. Allowing interest at  $3\frac{1}{2}$  per cent. per annum, what sum of money will now discharge a debt of £903. 11s. 3d. which becomes due 11 months hence?

10. A rectangular cistern  $10\frac{1}{8}$  feet in length,  $6\frac{1}{4}$  feet in breadth, and  $3\frac{1}{2}$  feet in depth, contains  $140\frac{5}{8}$  cubic feet of water. What is the least number of bricks, each 9 inches long, by  $4\frac{1}{2}$  inches wide, by 3 inches thick, that must be thrown into the cistern to make the water rise to the top, a brick being found to absorb water to the extent of one-fifth of its volume?

11. Would it be more advantageous to invest in the  $3\frac{1}{2}$  per cents. at  $80\frac{1}{2}$  or in the 4 per cents. at  $93\frac{1}{2}$ ?

12. A field containing 26 ac. 3r. 10p. is let in equal allotments to 66 agricultural labourers at a rental of 3d. a pole per annum, a reduction of 15 per cent. being offered to those tenants who shall pay their rent on the day that it becomes due. When all the year's rents have been paid, the landlord finds that he has received the sum of £49. 4s. 9d. How many labourers paid to the day?

### XXXII.

*Cambridge Local Examinations. Senior Students*

*December, 1887.*

1. Multiply 26 cub. ft. 1727 cub. in. by 1728

2. Seven years ago the rent of a farm of 240 ac. 3 r. was reduced from £541. 13s. 9d. a year to such a sum that the total reduction of rental in the interval has amounted to £1116. 9s. 6 $\frac{1}{2}$ d. For how much per acre is the farm let now?

## 3. Divide

(a)  $\cdot 0060472785$  by  $8\cdot 301$ .

(b) 
$$\frac{3}{2 + \frac{2}{3 + \frac{2}{3 + \frac{2}{3}}}}$$
 by  $\cdot 000039$ .

4. In the early part of the year the Government offered to take French bronze pennies from the public at the rate of 13 for a shilling. The Government would be able to exchange them again at the rate of 252 for a sovereign. What would the Exchequer gain or lose on every million pennies so received?

5. What decimal multiplied by  $\frac{1}{7}$  will be equal to the sum of  $\frac{1}{11830}$  and  $\frac{1}{16731}$ ?

6. Find by Practice the value of 11 oz. 13 dwts. 8 grs. of gold at £3. 17s. 10½*d.* per oz.

7. What is a concrete number?

Simplify 
$$\frac{£1. 18s. 6d.}{1078d.} + \frac{\cdot 35648\bar{1} \text{ cub. feet.}}{1078 \text{ cub. in.}}$$

8. At what rate per cent. simple interest will £868. 0s. 3*d.* produce £144. 13s. 4½*d.* in 5½ years?

9. An engine while driving machinery burns coal at the rate of 1 ton 12 cwt. 2 qrs. in 8 hrs. 40 min. When the machinery is not in motion, the consumption of coal is only  $\frac{4}{11}$  of this rate.

How much coal will the engine burn in 1584 hours, during  $\frac{1}{9}$  of which time the machinery is at rest?

10. If the 3 per cent. Consols are at 92½, what sum of money must be invested in this stock to get an income of £630 a year?

If the purchaser afterwards sells out at 94 and invests the proceeds so as to produce 3½ per cent. per annum, what change will take place in his income? (No brokerage to be reckoned.)

11. A cubical block of metal of 7·84 inches side weighs ·25 lbs. per cub. inch. A hole of square sectional area is to be cut completely through the metal perpendicular to a face of the cube, in order that the weight of metal left may be 100 lbs. Find to three places of decimals the side of the square section.

12. An armourer undertakes to supply 2000 swords at 17s. 3d. each. He estimates that if 5 per cent. fail to stand the required test and are worthless, the profit will be 15 per cent. on his whole outlay. At the trial, 35 per cent. of the swords prove worthless. How much does the armourer lose by the contract?

### XXXIII.

*Oxford and Cambridge School Examinations. 1884.*

1. Express 5,000,303 farthings in £. s. d., and subtract the result from 10,021 guineas.

2. Simplify 
$$\frac{5\frac{3}{4} - \frac{3}{7} \text{ of } 15\frac{3}{4} + 2\frac{2}{35} \div 1\frac{11}{25}}{\frac{3}{4} \text{ of } 7\frac{3}{7} - 5\frac{3}{5} \div 3\frac{4}{15}}.$$

3. Divide 1 by ·0625; and find a vulgar fraction whose value is equal to ·078.

4. A French metre contains 39·371 English inches. Find the number of metres in an English mile correct to two places of decimals.

5. Find the value of

$$\frac{3}{4} \text{ of } \text{£}5. 7s. 11d. + \frac{4}{3} \text{ of } \text{£}20. 5s. 9\frac{1}{2}d. - \frac{16}{9} \text{ of } \text{£}11. 12s. 6d.;$$

and reduce the result to the decimal of a guinea.

6. Find the rent of 25 acres, 3 roods, 15 poles, 2 $\frac{1}{2}$  sq. yds., at £2. 15s. per acre.

7. Find the difference between the interest on £266. 13s. 4d. for 3 months at 4 $\frac{1}{2}$  per cent. per annum, and the discount on £83 due 15 months hence at 3 per cent. per annum.

8. Divide £523. 10s. among three persons, *A*, *B*, and *C*, so that *A* may get one-third of what *B* receives, and *C* may receive as much as *A* and *B* together.

9. What percentage of the contents of a cask of spirits must be replaced by water so that a merchant may gain 25 per cent. by retailing the mixture at the same price per gallon as he paid for the undiluted spirit?

10. A man has £3,000 which he invests partly in a 3 per cent. stock at 96, and partly in a 6 per cent. stock at 108. He makes  $3\frac{1}{2}$  per cent. on the whole investment. What sums does he invest in each stock?

11. A square field contains 22 acres 2 roods: how long will it take a man to run round the boundary, running at the rate of 12 miles an hour?

If the field be increased by 9 acres, so as to form a rectangle whose shorter side is the former side of the square, at what rate does a man run who runs round it in 1 min. 39 sec. longer than was occupied in running round the square field?

12. *A* and *B* ride a race of 31 miles on bicycles. The driving wheel of *A*'s machine makes 3,410 revolutions per hour and has a circumference of 168 inches; that of *B* makes 3,520 revolutions per hour, and has a circumference of 162 inches: which will win, and by how much?

### XXXIV.

*Oxford and Cambridge School Examinations.* 1885.

1. In a certain sum the dividend is 31884740, the quotient 40930: find the divisor and remainder.

2. Simplify 
$$\frac{3}{3 - 1 \div \left(3 - \frac{1}{3}\right)} \div \frac{6 - 1 \div \left(6 - \frac{1}{6}\right)}{6\frac{3}{8}}.$$

3. Reduce the following fractions to decimals:—

$$\frac{19}{35}, \frac{.06059}{.073}, \text{ and } \frac{.214285\bar{7}}{.58730\bar{1}},$$

4. At a bankrupt's valuation his bullocks were put at £25 a head. They afterwards sold, one-half at £24. 9s. a head, and one-half at £26. 6s. a head: and thus £15 were realized more than was expected. How many bullocks had he?

5. Find the value of  $\frac{2}{5}$  of  $\frac{3}{8}$  of a sovereign -  $\frac{1}{7}$  of  $\frac{5}{6}$  of a guinea: and express the difference as the decimal of a crown.

6. A boy swims 3 miles in  $5\frac{1}{2}$  hours. He goes 1 ft. 4 in. by each stroke. How many strokes does he take a minute?

7. Find, by Practice, the rent of 643 acres 1 rood 27 poles of land at £1. 16s. 8d. per acre.

8. If the rate of interest is £3. 6s. 8d. per cent. per annum, what is the principal upon which the interest will amount to £9. 0s. 6 $\frac{3}{4}$ d. in 13 months?

9. A square field contains  $2\frac{1}{2}$  acres. The cost of making a path is 1s. 6d. per square yard. What is the cost of making a path three yards wide inside the field round the boundary?

10. At what time between 3 and 4 o'clock is the minute hand of a watch at right angles to the hour hand?

11. *A*, *B*, and *C* start in business together: *A* puts in £5000, *B* £6000, and *C* £9000. At the end of 3 months *C* leaves, and at the end of 7 more *B* leaves, both taking out their capital with them; but the profits are not divided till the end of the year, when *C* receives £50. How much will *A* and *B* then receive?

12. A man invests a certain sum in the ordinary stock of a railway at 90, which pays a dividend of  $3\frac{1}{2}$  per cent. at the end of a year. He then sells out at 86 and invests the proceeds in a seven per cent. stock at 98, and thus in the second year receives £647. 10s. more for interest than in the first year. How much did he originally invest, assuming that the prices of the stocks given above include brokerage, &c.?

## XXXV.

*Oxford and Cambridge School Examinations. 1886.*

1. How may it be ascertained (without actual division) whether a given number is divisible by 3, by 6, by 9, or by 25?

Divide the product of 999999 and 1955 by the continued product of 37, 13, 17, 7 and 23.

2. Simplify

$$(i) \left( \frac{2\frac{1}{5}}{3\frac{2}{3}} + \frac{400}{8\frac{1}{3}} - 4\frac{1}{2} \text{ of } 5\frac{1}{5} \right) \div 5\frac{5}{11} + \frac{3}{5} \text{ of } 1\frac{1}{250} + \frac{1}{250}.$$

$$(ii) (.5 + .75) \times (2.5 - .4) \div \left( .125 + \frac{1}{4.8} \right).$$

3. Two recurring decimals are added together; prove that the number of digits in the period of the result cannot exceed the product of the numbers of the digits in the original periods.

Simplify  $3.4\dot{1}0 + 1.0\dot{0}19\dot{1} - .24\dot{9}7\dot{9}$ .

Divide  $37.4\dot{3}6$  by  $.13\dot{0}$ .

4. Express £17. 16s. 8½d. as a decimal in terms of £1.

Find the ratio of 11⅔ of 14 tons 4 cwt. 2 qrs. 18⅔ lbs. to 21 tons 7 cwt.

5. Find the value of 841½ cwt. at £21. 13s. 7½d. per cwt.

6. Find the compound interest on £5432. 11s. for 3 years at 4½ per cent. (to the nearest penny).

7. Find the cost of making a road half-a-mile long, 36 ft. wide; the soil being first excavated to a depth of one foot at a cost of 1s. per cubic yard, rubble being then laid in, 9 inches deep, at a cost of 1s. 6d. per cubic yard, and 3 inches of gravel, at 3s. 3d. per cubic yard, being laid on the top, and the whole consolidated by a steam-roller at a cost of 2d. per square yard.

8. Divide £383 among four persons, so that the first may have thrice as much as the second, the third twice as much as the fourth, and the first and second together £95 more than the third and fourth together.

9. When 52 lbs. of coffee are worth as much as 12 lbs. of tea, 22 lbs. of tea are worth as much as 572 lbs. of sugar, a cask of sugar costs 2 guineas, and 1 cwt. of coffee costs 8 guineas, what is the weight of a cask of sugar?

10. In a hundred yards race *A* can beat *B* by 4 yards; in a quarter of a mile race *C* can beat *A* by 11 yards; by how much can *C* beat *B* in a mile race, supposing that the average speeds of each man when running a hundred yards, a quarter of a mile, and a mile, are proportional to 9 : 8 : 7?

11. What rate of interest per annum does a man get for his money when, in discounting a bill due in 10 months, he deducts as discount 4 per cent. of the total amount of the bill?

12. I invest equal sums in a 4 per cent. stock and in a 3 per cent. stock, and get 5 per cent. for my money; the 4 per cents. are at 90; what is the price of the 3 per cents.?

### XXXVI.

*Oxford and Cambridge School Examinations.* 1887.

1. Find the G.C.M. of 1019527 and 1231845.

2. (i) Find the value of

$$\frac{29}{105} + \frac{4}{35} \text{ of } 1\frac{3}{4} - \frac{7}{11} \text{ of } 3\frac{2}{3} \text{ of } \frac{6}{49}.$$

(ii) Add together

$$1\frac{5}{11} \text{ of } \text{£}7. 14s. 5\frac{1}{2}d. \text{ and } \frac{5}{21} \text{ of } \text{£}6. 2s. 6d.$$

3. Divide .00371 by 1.28 and simplify

$$\frac{2\cdot791\dot{6} \times 3\cdot2\dot{3}\dot{7}}{1\cdot86\dot{1} \times \cdot809\dot{3}\dot{4}}$$

4. Reduce 33 yards to the decimal of a mile, and find the number of pounds in

$$\cdot175 \text{ of a ton} + \cdot10\dot{7}1428\dot{5} \text{ of a cwt.} + \cdot15 \text{ of a lb.}$$

5. Find by Practice the value of 1215 articles at £4. 11s. 9½d. each.

6. Find the cost of painting the four sides and the bottom of a tank  $2\frac{1}{2}$  yards long,  $\frac{1}{4}$  feet wide, and  $4\frac{1}{2}$  feet deep at  $4d.$  per square foot.

7. What annual income is gained by investing £1900 in the  $3\frac{1}{2}$  per cents. at 95? Find the change in income if the stock be sold at 90, and the proceeds re-invested in the 3 per cents. at 81.

8. An article of commerce passes successively through the hands of three dealers, each of whom in selling adds as his profit 10 per cent. of the price at which he bought it. What did the first dealer pay for goods which the third dealer sells for £11. 1s. 10d.?

9. The debts of a bankrupt amount to £1067. 5s. 3d., and his assets consist of property worth £458. 7s. 8d., and an undiscounted bill of £256. 10s. due 4 months hence, simple interest being reckoned at 4 per cent. How much in the pound will he pay?

10. In how many years will the compound interest at 5 per cent. per annum on £1250 amount to £197. 0s.  $7\frac{1}{2}d.$ ?

11. A man travels 60 miles in 3 hours, partly by rail and partly by coach. If he had gone all the way by rail he would have arrived at his destination an hour earlier, and would have saved two-fifths of the time he was on the coach. How far did he travel by coach?

12. Find the cube root of  $1277289\frac{27}{216}$ .

[Any number of the following six questions may be substituted for an equal number of the preceding six.]

a. If 4cwt. 1qr. 26lbs. of tobacco can be bought for £56. 9s. 6d., what quantity can be purchased for £4. 19s. 9d.?

b. If 90 men can dig a ditch 50 yards long in  $4\frac{1}{2}$  days, how many men can dig a ditch 360 feet long in 27 days?

c. What is the discount on £1025, due 2 years 8 months hence, the rate of simple interest being  $3\frac{1}{2}$  per cent.?

d. If I buy an article for 10s. 6d. and sell it for 14s., what is my gain per cent.?

e. A can do a piece of work in 6 days, B in 8 days, and C in 12 days. B and C work together for 2 days, and then C is replaced by A. Find when the work will be finished.

f. Extract the square root of 676·208016.

## XXXV:II.

*Oxford and Cambridge School Examinations. 1887.*

*(For Lower Certificates.)*

1. A father leaves £1191. 13s. 4d. to be divided equally between his seven sons and six daughters. How much will each receive?

Also how much would each have received if the share of each son had been double of the share of each daughter?

2. Each ton of ore obtained from a gold-mine yields on the average 2 oz. 1 dwt. 15 grs. of fine gold. How much fine gold will be obtained from 293 tons?

3. How many half-crowns are there in 6705 guineas?

4. Find the least common multiple of 42, 64, 70, 80, 112, and reduce  $\frac{1786}{2451}$  to its lowest terms.

5. Subtract  $3\frac{7}{15} + 2\frac{11}{12}$  from  $3\frac{4}{5} + 1\frac{5}{16} + 4\frac{3}{20}$ .

6. (1) Express 12s. 4 $\frac{3}{4}$ d. as a fraction of £1. 10s. 1 $\frac{1}{4}$ d.

(2) Find the number of feet in  $\frac{3}{5}$  of a mile +  $\frac{1}{2}$  of a furlong -  $11\frac{1}{2}$  poles.

7. (1) Divide .43104 by .00768.

(2) Express in £. s. d. the value of 1.62 acres at £26.09375 per acre.

8. Find by Practice the value of 345 shares at £40. 16s. 9d. each; also of 27 tons 14 cwt. 3 qrs. 14 lbs. of hay at £4. 16s. per ton.

9. A man's hotel bill for 4 weeks 5 days amounted to £28. 17s. 6d. How much would he have had to pay at the same rate for 6 weeks 4 days?

10. Find the simple interest on £1368. 15s. for 106 days at  $4\frac{3}{4}$  per cent.

11. A watch which gains 5 seconds in every 3 minutes was set right at 6 A.M. What was the true time in the afternoon of the same day when the watch indicated a quarter past 3 o'clock?

## XXXVIII.

*Responsions. Oxford. Michaelmas Term, 1887.*

1. Find the L. C. M. of 143, 78, 91, 637, 286, 156.

2. Simplify  $\frac{\frac{7}{8} + \frac{1}{2} - \frac{8}{21}}{10 \frac{1}{12} \times \frac{4}{5} \times \frac{15}{77} \times \frac{7}{11}} - \frac{834}{840}$ .

3. Multiply 7642 by  $\cdot 121$ , and divide 1761 by  $\cdot 5283$ .

4. A grocer bought 1 ton 11 cwt. 3 lbs. of sugar at  $2\frac{1}{4}d.$  a lb. How much in all did he pay for it?

5. A debtor owing £11500 paid a composition of 6s. 3d. in the pound. How much would a creditor to whom  $\cdot 2$  of the whole was owing receive?

6. Extract square roots of 277729, 25 $\cdot$ 5025,  $22\frac{11}{49}$ .

7. How much will it cost to paper a room 18 ft. 6 in. broad by 20 ft. long and 11 ft. high, with paper costing 9d. per square yard? The room has a door 4 ft. broad by 7 ft. high, and a window 5 ft. broad by 8 ft. high.

8. How many times will a bicycle wheel 12 feet in circumference revolve between two places, *A* and *B*, distant 12 miles 1 furlong and 12 perches from each other.

9. What sum of money will amount to £769. 5s. at the end of  $8\frac{1}{2}$  years at 4 per cent. simple interest?

10. A person invests £5740 in a  $3\frac{1}{2}$  per cent. stock at  $71\frac{1}{4}$ . What is his yearly income and how much per cent. does he obtain for his money?

**XXXIX.**

*Responsions, Oxford. Trinity Term, 1887.*

1. Simplify  $\frac{1\frac{1}{2} + 2\frac{2}{3} + 3\frac{5}{6}}{\frac{4}{5} \text{ of } \frac{3}{4} \text{ of } 2\frac{1}{3}}$  and  $\frac{\frac{1}{3} + \frac{1}{5}}{\frac{2}{3} \cdot \frac{1}{7} + \frac{1}{8}}$ .

2. Multiply 35·623 by ·00125; and divide 3·015 by ·012.

3. Find the value of

$$\frac{4}{15} \text{ of } \pounds 1 + \frac{5}{8} \text{ of } 1s. + \frac{5}{28} \text{ of a guinea} + \frac{3}{5} \text{ of } \pounds 1. 6s. 8d.$$

4. Find by Practice the worth of a crop on 15 ac. 3 rds. 17 pls. at £15. 13s. 4d. an acre.

5. Find the square roots of 21893041,  $\frac{121}{361}$ , 4·41.

6. A truck of coals containing 8 tons is sold at the pit's mouth for 13s. a ton, and delivered at a railway station distant 120 miles for £7. 14s. What is the cost of carriage per ton per mile?

7. A creditor received 2s. 8d. in the £, and thereby lost £433. 6s. 8d.; how much was due to him?

8. A sells his house for £1855 and gains thereby 6 per cent. on the original cost. How much per cent. would he have lost by selling it at £1715?

9. If 12 men could dig 12 roods of ground in 12 days working 12 hours a day, how many roods of ground could 8 men dig in 8 days working 8 hours a day?

10. At what rate per cent. per annum will £2500 amount to £2865. 12s. 6d. in  $3\frac{1}{4}$  years at simple interest?

11. What is the price of three per cent. stock, when a sum of £2176. 12s. 3d. invested will produce an income of £66. 2s. 6d. per annum?

## XL.

*Previous Examination, Cambridge.**October, 1885.*

1. Find the greatest common measure of 149291688 and 2194920.

2. Divide £443716. 2s. 1d. into 817 equal parts.

3. Shew that the value of a fraction is not altered by dividing its numerator and its denominator by the same number.

$$\text{Simplify } \frac{31\frac{1}{3} - 22\frac{1}{5}}{11\frac{1}{5} - 1\frac{1}{7}} \div 1\frac{49}{88} + 2\frac{5}{12}.$$

4. Convert to decimals  $\frac{17}{37}$  and  $\frac{3}{64}$ , and find the value of  $1\cdot0990 \times 2\cdot729$ .

5. Divide 61·75 by ·325, and ·06175 by 3·25.

6. Find the length of a side of a square whose area is 576 sq. yards 2 sq. feet 57·64 sq. inches.

7. Find the cost of 2 tons 11 cwt. 27 lbs. at £13. 3s. 8d. per cwt.

8. Find the compound interest on £133. 6s. 8d. for three years at  $2\frac{1}{2}$  per cent.

9. The total area of three estates is 1768 acres. If the areas of the two smaller estates be respectively three-fifths and two-thirds that of the largest, find the acreage of each.

10. By paying an income-tax of ninepence in the pound a man's income is reduced to £1212. 15s. Find (1) his original income, and (2) the sum of money which must be invested in  $4\frac{1}{2}$  per cent. stock at 110 $\frac{1}{2}$  to produce that income, a brokerage of  $\frac{1}{8}$  per cent. being charged on the purchase of the stock.

## XLI.

*Previous Examination, Cambridge.**December, 1886.*

1. Subtract 276 from 514, and explain each step of the process.

2. A swimmer takes 22 strokes a minute and goes  $2\frac{1}{2}$  yards each stroke: how long does it take him to swim a quarter of a mile?

3. The rent of a farm of 576 acres 3 roods is £937. 4s.  $4\frac{1}{2}d.$ : what is the rent per acre?

4. A ton of sugar costs £11. 13s.  $4d.$ : how much will 8 cwt. 3 qrs. 20 lbs. cost at the same rate?

5. Find the greatest number which will exactly divide both 618234 and 712923; find also the smallest number which is exactly divisible by both the numbers.

6. Define a fraction, and prove that the value of a fraction is unaltered by multiplying its numerator and its denominator by the same number.

What fraction of 35 shillings is equal to the sum of  $2\frac{3}{4}$  of 7s. 6d. and  $\frac{3}{2} \times \frac{5}{4}$  of 3s.?

7. A rectangular field is 214·35 yards long and 123·26 yards wide. Express its area in acres, roods and poles; and find, to within an inch, the side of a square field of equal area.

8. A man bought 12 sheep for £30, and 10 oxen for £105. He sold the sheep at a gain of 10 per cent., and the oxen at a gain of 8 per cent. What was his total profit?

9. Find, to the nearest penny, the compound interest on £350. 12s. 6d. in 5 years at 4 per cent. per annum.

10. A man invests equal sums in the 3 per cents. at 96, and in 4 per cent. railway debentures at 120. What percentage did he get for his money in each case, and what percentage on the whole?

## XLII.

*Army Preliminary Examination. August, 1885.*

1. Add together  $3\frac{12}{13}$ ,  $2\frac{11}{20}$ ,  $\frac{21}{26}$ , and  $4\frac{3}{5}$ .
2. Subtract  $18\frac{19}{25}$  from  $25\frac{17}{30}$ .
3. Multiply together  $2\frac{18}{49}$ ,  $\frac{19}{255}$ ,  $1\frac{6}{29}$ , and  $1\frac{13}{38}$ .
4. Divide  $8\frac{17}{32}$  by  $1\frac{43}{48}$ .
5. Add together 43·587, ·60935, 501·097, and 1·8329.
6. Subtract 45·82736 from 59·0329.
7. Multiply 11·82075 by ·003961.
8. Divide 4·0975 by ·2980.
9. Express 1 qr. 10½ lbs. as the decimal of a cwt.
10. If 3½ lbs. can be bought for £1. 17s. 4d., how much can be bought for £106. 2s. 8d.?
11. Reduce 3 acres 1 rood 4 perches 3 yards to square feet.
12. Find the simple interest on £215 in  $4\frac{1}{2}$  years at  $3\frac{3}{4}$  per cent. per annum.
13. Add together  $3\frac{5}{9}$ ,  $\frac{11}{16}$ ,  $2\frac{14}{27}$ , and  $\frac{11}{72}$ .
14. Subtract  $28\frac{29}{50}$  from  $32\frac{17}{65}$ .
15. Multiply together  $\frac{24}{121}$ ,  $\frac{16}{43}$ ,  $1\frac{3}{8}$ , and  $5\frac{11}{15}$ .
16. Divide  $\frac{33}{52}$  by  $5\frac{25}{39}$ .
17. Add together ·029 of 1 day 3 hours, ·45 of 11 hours 10 minutes, and ·89 of an hour, and express the answer in minutes and the decimal of a minute.

18. Subtract  $\cdot 0523$  of £1. 11s. 6d. from  $\cdot 29$  of 15s. 3d., and give the answer in pence and the decimal of a penny.

19. Multiply 4·807309 by 12·086.

20. Multiply 2·394 by  $2\frac{28}{431}$ , and express the answer as a decimal.

21. Divide 2·873 by 48·607 to six places of decimals.

22. Divide 3·43 by  $5\frac{7}{81}$ , and express the answer as a decimal.

23. At what rate per cent. simple interest will £1350 amount to £1621. 13s. 9d. in  $5\frac{3}{4}$  years?

24. A man sells a horse for £12 more than he gave for it, and realizes a profit equal to  $\frac{7}{8}$ ths of its cost price. What was its cost price?

25. Find the value of 368724 articles at 13s. 4d. per score.

26. A's rate of working is to B's as 4 to 3, and B's is to C's as 2 to 1. How long will it take C to do what A would do in 6 days?

### XLIII.

*Army Preliminary Examination. February, 1886.*

1. Add together  $\frac{7}{12}$ ,  $3\frac{4}{15}$ ,  $\frac{11}{30}$ , and  $2\frac{5}{9}$ .

2. Subtract  $13\frac{15}{22}$  from  $17\frac{7}{165}$ .

3. Multiply together  $9\frac{5}{8}$ ,  $1\frac{71}{121}$ ,  $1\frac{1}{104}$ , and  $2\frac{45}{49}$ .

4. Divide  $2\frac{26}{75}$  by  $1\frac{31}{35}$ .

5. Add together 372·0647, 41·62835, ·964738, and 876.

6. Subtract 28·7643 from 37·593165.

7. Multiply 39·0437 by 5·40305.

8. Divide  $\cdot 15104932$  by  $40\cdot 13$ .
9. Reduce  $\cdot 4065$  of 3 acres 2 roods 7 perches to square feet and the decimal of a square foot.
10. A silver cup, weighing 1 lb. 2 oz. (Troy), is sold by weight for £3. 0s.  $4\frac{1}{2}d.$ , what is the value per ounce?
11. In 134675 inches how many miles, furlongs, poles, yards, &c.?
12. Find the simple interest on £750 in  $4\frac{1}{2}$  years at  $3\frac{1}{4}$  per cent. per annum.
13. Add together  $5\frac{8}{17}$ ,  $\frac{17}{20}$ ,  $4\frac{11}{85}$ , and  $\frac{8}{51}$ .
14. Subtract  $47\frac{23}{27}$  from  $55\frac{16}{63}$ .
15. Multiply together  $11\frac{7}{11}$ ,  $\frac{15}{86}$ ,  $5\frac{1}{24}$ , and  $2\frac{11}{16}$ .
16. Divide  $\frac{64}{273}$  by  $1\frac{5}{91}$ .
17. Add together  $1\cdot 47$  of 3s. 6d.,  $\cdot 053$  of £1. 4s., and  $\cdot 125$  of  $7\frac{1}{2}d.$ , and express the answer in pence and the decimal of a penny.
18. Subtract  $\cdot 075$  of 3 bushels 1 peck from 2 pecks 3 quarts, and express the answer in pints and the decimal of a pint.
19. Multiply  $\cdot 72465$  by  $\cdot 04306$ .
20. Multiply  $1\cdot 319$  by  $\cdot 381$ , and express the answer as a decimal.
21. Divide  $64\cdot 375$  by  $9\cdot 573$  to four places of decimals.
22. Divide  $\cdot 388$  by  $12\cdot 44$ , and express the answer as a decimal.
23. In what time will £5027. 10s. amount to £5593. 1s.  $10\frac{1}{2}d.$  at  $2\frac{1}{2}$  per cent. per annum, simple interest?
24. A room 22 feet 6 inches long, and 15 feet 9 inches wide, is to be covered with floor-cloth  $1\frac{1}{2}$  yards wide. How many yards are required, and what will be the cost at 3s. 6d. per square yard?

25. Find the value of 3766 lbs. at 8s. 10½d. per stone of 14lbs.

26. When *A* and *B* commence walking towards each other they are 37½ miles apart; they walk uniformly at the respective rates of 3½ and 4 miles an hour until they meet. How long will this be after they set out, and how many miles will each have walked?

### XLIV.

*Army Preliminary Examination. March, 1886.*

1. Add together  $5\frac{7}{12}$ ,  $\frac{12}{35}$ ,  $\frac{25}{48}$ , and  $2\frac{2}{5}$ .
2. Subtract  $15\frac{19}{27}$  from  $26\frac{8}{63}$ .
3. Multiply together  $4\frac{3}{35}$ ,  $\frac{27}{58}$ ,  $\frac{15}{44}$ , and  $5\frac{8}{39}$ .
4. Divide  $4\frac{31}{36}$  by  $2\frac{17}{54}$ .
5. Add together .7055, 324.88, 7.08213, and .0621.
6. Subtract 30.85762 from 75.4017.
7. Multiply 13.7305 by .006507.
8. Divide 11.7813 by .2724.
9. Reduce .0752 of 1 ton 3 cwt. 15½ lbs. to lbs. and the decimal of a lb.
10. If 1 oz. 4 dwt. 9 grs. cost 15s. 6¼d., what is the price of 5 oz. 17 dwt.?
11. Reduce 5 miles 2 furlongs 3 yards to feet.
12. Find the simple interest on £257 in 5½ years at 2½ per cent. per annum.
13. Add together  $4\frac{5}{9}$ ,  $\frac{14}{15}$ ,  $3\frac{40}{81}$ , and  $\frac{11}{30}$ .
14. Subtract  $28\frac{32}{35}$  from  $42\frac{16}{63}$ .

15. Multiply together  $\frac{25}{117}$ ,  $14\frac{7}{16}$ ,  $\frac{72}{77}$ , and  $1\frac{29}{75}$ .

16. Divide  $\frac{51}{64}$  by  $7\frac{7}{16}$ .

17. Add together  $\cdot 029$  of 1 acre 1 rood,  $\cdot 45$  of  $12\frac{1}{2}$  poles, and  $\cdot 89$  of 2 sq. yards, and express the answer in sq. ft. and the decimal of a sq. foot.

18. Subtract  $\cdot 0523$  of 11 weeks from  $\cdot 932$  of 6 days, and give the answer in minutes and the decimal of a minute.

19. Multiply  $5\cdot 80446$  by  $\cdot 10765$ .

20. Multiply  $4\cdot 3153$  by  $103\cdot 9896$ , and express the answer as a decimal.

21. Divide  $3\cdot 743$  by  $52\cdot 804$  to five places of decimals.

22. Divide  $2\cdot 394$  by  $30\frac{250}{279}$ , and express the answer as a decimal.

23. In what time will £1500 amount to £1865. 12s. 6d. at  $3\frac{1}{2}$  per cent. per annum simple interest?

24. If 15 men can do as much work in the same time as 21 boys, how long will it take 25 men to do what 30 boys do in 14 hours?

25. Find the value of 35688 articles at £1. 11s.  $9\frac{3}{4}$ d. per doz.

26. Coals rise from 15s. 9d. to 18s. 6d. per ton. What is the extra expense to a firm laying in 24 tons, an amount which is  $\frac{1}{3}$ th less than their usual supply?

## XLV.

*Army Preliminary Examination. July, 1886.*

1. Add together  $7\frac{5}{14}$ ,  $\frac{13}{36}$ ,  $1\frac{6}{11}$ , and  $\frac{1}{77}$ .

2. Subtract  $13\frac{11}{52}$  from  $15\frac{27}{143}$ .

3. Multiply together  $1\frac{31}{104}$ ,  $\frac{76}{117}$ ,  $\frac{34}{57}$ ,  $\frac{33}{85}$ .

4. Divide  $1\frac{214}{325}$  by  $2\frac{57}{143}$ .
5. Add together  $\cdot7099$ ,  $99\cdot522$ ,  $3\cdot02022$ , and  $\cdot001717$ .
6. Subtract  $29\cdot78787$  from  $31\cdot010101$ .
7. Multiply  $10\cdot1032$  by  $\cdot010987$ .
8. Divide  $246\cdot8754211$  by  $\cdot07777$ .
9. Reduce  $\cdot0375$  of 3 acres 3 roods 7 poles, to sq. feet and the decimal of a sq. foot.
10. What part of 27 fathoms is  $1\frac{1}{14}$  of  $12\frac{5}{8}$  yards?
11. Reduce 29 lbs. 3 oz. 13 dwts. 21 grs. to grains.
12. Find the simple interest on £440 for  $3\frac{1}{4}$  years at  $2\frac{1}{2}$  per cent. per annum.
13. Add together  $2\frac{6}{7}$ ,  $\frac{34}{35}$ ,  $1\frac{1}{125}$ , and  $\frac{24}{25}$ .
14. Subtract  $13\frac{38}{39}$  from  $17\frac{37}{65}$ .
15. Multiply together  $\frac{93}{128}$ ,  $1\frac{163}{187}$ ,  $\frac{22}{35}$ ,  $2\frac{6}{31}$ .
16. Divide  $1\frac{8}{49}$  by  $13\frac{4}{7}$ .
17. Add together  $\cdot3025$  of £9. 7s. 6d.,  $1\cdot3628$  of 10s., and  $\cdot0674$  of 10d., and express the answer in francs and centimes. (1 franc =  $9\frac{1}{2}$ d.)
18. Find in miles, the difference between  $\cdot99999$  of a degree and 59 miles 2 furlongs. (1 deg. =  $69\frac{1}{8}$  miles.)
19. Multiply  $\cdot73001$  by  $7\cdot30121$ .
20. Multiply  $\cdot212121$  by  $1\cdot0499895$ , and express the answer as a decimal.
21. Divide  $1\cdot11$  by  $8\cdot0908$  to 5 places of decimals.
22. Divide  $1\frac{1}{1089}$  by  $\cdot202$ , and express the result as a decimal.
23. In what time will £3100 amount to £3384. 3s. 4d. at  $3\frac{1}{2}$  per cent. per annum simple interest?

24. Divide £40. 17s. 5d. among three persons, *A*, *B*, *C*: so that *A* may have £2. 18s. 7d. more than *B*, and *B* £1. 18s. 2d. more than *C*.

25. Find the value of 777 yds. 2 ft. 3 in. of silk at 22s. 8d. a yard.

26. Determine the order of magnitude of  $\frac{31}{91}$ ,  $\frac{41}{119}$ ,  $\frac{51}{143}$ , and express the difference of the two less in terms of the difference of the two greater.

### XLVI.

*Army Preliminary Examination. August, 1886.*

1. Add together  $\frac{3}{5}$ ,  $6\frac{7}{65}$ ,  $4\frac{17}{130}$ , and  $2\frac{9}{20}$ .
2. Subtract  $12\frac{6}{35}$  from  $13\frac{9}{280}$ .
3. Multiply together  $11\frac{10}{13}$ ,  $\frac{35}{88}$ ,  $\frac{121}{136}$ ,  $5\frac{7}{9}$ .
4. Divide  $1\frac{93}{232}$  by  $3\frac{51}{58}$ .
5. Add together 4·79093, 59·6358, ·002503 and 5·7015151.
6. Subtract 9·099901 from 10·00901.
7. Multiply ·053076 by 98·0035.
8. Divide 41·2666368 by ·05888.
9. Reduce ·6125 of 4 miles 4 fur.  $3\frac{1}{2}$  feet to inches and the decimal of an inch.
10. Express  $2\frac{11}{12}$  of  $13\frac{1}{7}$  pints as a fraction of 35 gallons.
11. Reduce 15 acres 3 roods  $19\frac{3}{4}$  yards to sq. feet.
12. Find the simple interest on £980 for  $5\frac{3}{4}$  years at  $3\frac{1}{2}$  per cent. per annum.
13. Add together  $2\frac{7}{45}$ ,  $\frac{13}{165}$ ,  $\frac{17}{60}$ , and  $5\frac{7}{9}$ .

14. Subtract  $11\frac{53}{98}$  from  $16\frac{15}{28}$ .
15. Multiply together  $\frac{65}{123}$ ,  $1\frac{5}{6}$ ,  $\frac{75}{121}$ , and  $1\frac{44}{325}$ .
16. Divide  $3\frac{17}{23}$  by  $1\frac{11}{161}$ .
17. Add together  $\cdot 0125$  of £5. 12s. 6d.,  $3\cdot 0057$  of 15s., and  $\cdot 15$  of 8d., and express the result as the decimal of £1 (4 places of decimals).
18. If a dollar equals 4·3 shillings, find in pounds and the decimal of £1 the difference between  $\cdot 6325$  of 10 dollars and £12. 17s. 3d.
19. Multiply  $3\cdot 12105$  by  $\cdot 905008$ .
20. Multiply  $\cdot 357$  by  $2\cdot 145$ , and express the answer as a decimal.
21. Divide  $\cdot 00094809768$  by  $\cdot 01567$ .
22. Divide  $\cdot 5609$  by  $5\frac{17}{90}$ , and express the answer as a decimal.
23. A sum of money put out for 10 years at  $3\frac{1}{2}$  per cent. simple interest amounts to £425. 19s.  $4\frac{1}{2}$ d.: what was the sum?
24. The sum of £25. 14s. 6d. is to be divided among seven boys, six women, and five men. If a woman has twice as much as a boy, and a man three times as much as a woman, what will each receive?
25. What is the rent of 650 acres 2 roods 8 poles at £5. 12s. 6d. an acre?
26. Find the vulgar fraction which is equal to the sum of  $15\cdot 3125$  and  $12\cdot 0075$  divided by their difference.

**XLVII.**

*Army Preliminary Examination. February, 1887.*

1. Add together  $\frac{9}{77}$ ,  $2\frac{7}{33}$ ,  $\frac{22}{63}$ , and  $7\frac{10}{11}$ .
2. Subtract  $7\frac{10}{13}$  from  $11\frac{11}{78}$ .
3. Multiply together  $5\frac{4}{9}$ ,  $\frac{12}{143}$ ,  $2\frac{1}{7}$ ,  $8\frac{29}{50}$ .
4. Divide  $\frac{77}{156}$  by  $15\frac{31}{39}$ .
5. Add together  $\cdot79093$ ,  $59\cdot6358$ ,  $\cdot002503$  and  $346\cdot0207$ .
6. Subtract  $12\cdot0360819$  from  $107\cdot00617$ .
7. Multiply  $98\cdot003535$  by  $\cdot0042074$ .
8. Divide  $\cdot304775546$  by  $59\cdot678$ .
9. Reduce  $\cdot61251$  of 4 bushels 3 gallons  $1\frac{1}{2}$  quarts to pints and the decimal of a pint.
10. Express  $\cdot3275$  of  $5\frac{3}{8}$  of 2 guineas as the decimal of £6.11s.
11. In 84304202 square inches how many acres, roods, &c.?
12. At what rate per cent. will the simple interest on £980 amount to £178. 8s. 10d. in 3 years and 2 months?
13. Add together  $2\frac{7}{46}$ ,  $\frac{38}{45}$ ,  $\frac{57}{230}$ , and  $9\frac{5}{9}$ .
14. Subtract  $9\frac{43}{220}$  from  $120\frac{7}{60}$ .
15. Multiply together  $\frac{18}{19}$ ,  $182\frac{1}{2}$ ,  $\frac{11}{219}$ , and  $4\frac{29}{45}$ .
16. Divide  $8\frac{1}{7}$  by 171.
17. Add together  $\cdot01425$  of 1 cwt. 12lbs.,  $\cdot4756$  of 1 qr. 15lbs., and  $5\cdot42$  of 7lbs. 4 oz., and express the result in lbs. and the decimal of a pound.

18. The Irish acre is to the English acre as 49 is to  $30\frac{1}{4}$ ; how many English acres are there in a farm containing  $852\frac{1}{2}$  Irish acres?

19. Multiply  $\cdot 0435075$  by  $3\cdot 40604$ .

20. Multiply  $4\cdot 608\bar{1}$  by  $\cdot 356\bar{7}$ , and express the answer as a decimal.

21. Divide  $4\cdot 997$  by  $\cdot 398\bar{4}$ , and express the answer as a decimal.

22. By what decimal must  $2\cdot 3902\bar{6}$  be divided to give  $\cdot 070\bar{2}$  as a quotient?

23. What sum bears the same proportion to £5 that  $13s. 11\frac{1}{4}d.$  does to £3. 14s. 4d.?

24. A general, having lost  $\frac{2}{7}$ th of his men in battle and 6 per cent. of the remainder by sickness, found he had 95880 men left; how many had he at first?

25. Find the value of 1527 articles at £3. 19s. 9d. per dozen.

26. A sum of £38 consisted of a certain number of half-crowns, twice as many florins, and three times as many shillings; how many were there of each?

### XLVIII.

*Army Preliminary Examination. March, 1887.*

1. Add together  $15\frac{24}{35}$ ,  $11\frac{7}{24}$ ,  $19\frac{17}{105}$ , and  $23\frac{25}{168}$ .

2. Subtract  $14\frac{15}{28}$  from  $19\frac{19}{84}$ .

3. Multiply together  $1\frac{67}{186}$ ,  $\frac{144}{161}$ ,  $2\frac{55}{112}$ , and  $1\frac{97}{99}$ .

4. Divide  $17\frac{3}{16}$  by  $1\frac{239}{256}$ .

5. Add together  $379\cdot 8503$ ,  $\cdot 0056178$ ,  $5\cdot 973$ , and  $1\cdot 50034621$ .

6. Subtract 23·907325 from 84·0157.
7. Multiply 76·035 by ·0580079.
8. Divide ·209784253 by 36·151.
9. Reduce ·5123 of 3 miles 1 furlong 15½ yards to inches and the decimal of an inch.
10. Express  $\frac{11}{17}$  of 1·13 of 2 cwt. 5 lbs. 8 oz. as the decimal of 1 ton.
11. In 8435798 sq. in., how many acres, roods, perches, &c.?
12. Find the simple interest on £1725 for 3½ years at 5½ per cent. per annum.
13. Add together  $6\frac{91}{198}$ ,  $5\frac{63}{286}$ ,  $19\frac{23}{156}$ , and  $27\frac{22}{39}$ .
14. Subtract  $15\frac{19}{34}$  from  $17\frac{11}{153}$ .
15. Multiply together  $\frac{51}{91}$ ,  $1\frac{27}{68}$ ,  $2\frac{46}{55}$ , and  $\frac{77}{171}$ .
16. Divide  $33\frac{3}{25}$  by  $2\frac{91}{265}$ .
17. Add together ·113 of 2 lbs. 11 dwt., 3·75 of 16 oz. 3 grs., and ·17 of 14 dwt. 9 grs., and express the result in grains and the decimal of a grain.
18. Subtract ·00107 of a quarter from ·1751 of 3 bushels 2½ gallons, and express the result in pints and the decimal of a pint.
19. Multiply 5·61023 by ·597001.
20. Multiply 43·372 by ·01332, and express the answer as a decimal.
21. Divide 174·13238 by 5·615.
22. Divide ·2317 by 1·158.
23. What principal will amount to £1751. 16s. 10½d. in 3½ years at 4½ per cent. per annum simple interest?

24. If a certain amount of work is done by 9 men, 12 women, and 13 boys in 11 days, how long will the same work take if 18 men, 3 women, and 5 boys are set to do it: assuming that the ratio of a man's work to a woman's is as 5 to 3, and a woman's work to a boy's as 4 to 3?

25. If a bankrupt pays 11s. 9½d. in the £, what will be the dividend on £5670?

26. How many days, hours, minutes, and seconds are there in .51623 of a week?

### XLIX.

*Army Preliminary Examination. August, 1887.*

1. Add together  $16\frac{4}{7}$ ,  $2\frac{15}{56}$ ,  $\frac{11}{48}$  and  $\frac{17}{35}$ .
2. Subtract  $23\frac{31}{64}$  from  $33\frac{23}{108}$ .
3. Multiply  $7\frac{7}{44}$  by  $2\frac{17}{63}$ .
4. Divide  $8\frac{11}{56}$  by  $2\frac{13}{70}$ .
5. Add together 24·5604, ·07365, 407·8604, and 1·00753.
6. Subtract 49·6703 from 85·62307.
7. Multiply ·020476 by 2·406.
8. Divide 1·13204182 by 24·0604.
9. Express 1·403 of 3 lbs. 2 oz. 3½ dwt. in grains and the decimal of a grain.
10. In 4076537 inches how many miles, furlongs, poles, yards, &c.?
11. Express ·0125 of 4 tons 19 cwt. 6 lbs. as the decimal of 3 cwt. 1 qr. 11 lbs.

12. Find the simple interest on £3725. 15s. in  $3\frac{1}{2}$  years at  $3\frac{1}{2}$  per cent. per annum.

13. Add together  $9\frac{4}{13}$ ,  $14\frac{23}{132}$ ,  $3\frac{17}{24}$ , and  $7\frac{9}{143}$ .

14. Subtract  $34\frac{46}{57}$  from  $63\frac{5}{76}$ .

15. Multiply together  $2\frac{14}{27}$ ,  $1\frac{11}{15}$ ,  $2\frac{7}{34}$ , and  $1\frac{5}{13}$ .

16. Divide  $6\frac{47}{138}$  by  $6\frac{21}{184}$ .

17. Add together  $\frac{3}{8}$  of  $7\frac{1}{2}$  cwt. and 2·07 of  $3\frac{1}{2}$  qrs., and express the answer in ounces and the decimal of an ounce.

18. Subtract ·657 of 2 acres from 7·042 of 1 rood, and express the answer in sq. yds. and the decimal of a sq. yd.

19. Multiply 43·7246 by ·24805.

20. Multiply 3·49 by ·469, and express the answer as a decimal.

21. Divide 4·7362 by ·0435 correctly to five places of decimals.

22. Divide 26·338 by 1·8626, and express the answer as a decimal.

23. In what time will £4725 at  $2\frac{1}{4}$  per cent. per annum simple interest amount to £5097. 1s.  $10\frac{1}{2}$ d.?

24. The travelling expenses of 7 tourists for 5 weeks amounted to £75. 5s.; a second party of 18 made the same tour in 6 weeks, their average weekly expenditure per man being  $\frac{4}{9}$  of that of the first party. What were the total expenses of the second party?

25. Find the dividend on £1483. 17s. at 8s.  $11\frac{1}{2}$ d. in the £.

26. Find a fourth proportional to 275, 2·75 and ·275.

## L.

*Army Preliminary Examination. February, 1888.*

1. Add  $2\frac{6}{7}$  to  $4\frac{11}{35}$ .
2. Subtract  $3\frac{5}{8}$  from  $6\frac{7}{68}$ .
3. Multiply  $\frac{11}{42}$  by  $\frac{28}{55}$ .
4. Divide  $\frac{13}{96}$  by  $\frac{65}{84}$ .
5. Add together 4·30726, 076428, 371·864, and 20·0472.
6. Subtract 47·063782 from 710·04681.
7. Multiply 40·637 by ·028403.
8. Divide 8·31183 by 23·05.
9. Reduce 1·047 of 2 weeks 5 hours to minutes and the decimal of a minute.
10. In 347693 inches, how many miles, furlongs, poles, yards, &c.?
11. What would a tax of 3s. 11d. in the pound amount to in £480?
12. Find the simple interest on £11175 in  $2\frac{1}{2}$  years at 3 per cent. per annum.
13. Add together  $5\frac{2}{5}$ ,  $\frac{17}{56}$ , and  $4\frac{5}{14}$ .
14. Subtract  $5\frac{11}{12}$  from  $9\frac{7}{132}$ .
15. Multiply together  $1\frac{11}{28}$ ,  $\frac{35}{36}$ , and  $2\frac{10}{13}$ .
16. Divide  $1\frac{29}{55}$  by  $\frac{108}{121}$ .

17. Add together  $\frac{5}{9}$  of 7s. 6d., 2·07 of £1. 8s. 2d., and  $\frac{3}{4}$  of ·0671 of 16s. 8d., and express the answer in pence and the decimal of a penny.

18. Multiply ·3949 by  $\frac{54}{395}$ .

19. Divide 23·648 by ·9459.

20. Express 11s. 0 $\frac{3}{4}$ d. as a decimal of £8. 17s.

21. If the interest on a certain sum of money amount to £119. 2s. 9d. in 2 years 3 months, what should be the interest on six times the amount in one-fourth the time, the rate being the same and the interest *simple* in both cases?

22. Is there any difference between the meaning of the sign  $\times$  in  $2 \times 7$  and in  $\frac{2}{3} \times \frac{7}{9}$ ? If there is, explain the difference fully.

## LI.

*Scotch Leaving Certificate, 1897.*

*Lower Grade.*

1. Find, by practice, the dividend on £7126. 10s. at 9s. 6d. in the pound.

2. A bronze medal is composed of copper, tin and zinc. If  $\frac{15}{19}$  of the medal be copper and  $\frac{1}{9}$  be tin, what fraction of it is zinc?

3. A square paddock contains 16 square poles, and is enclosed by hurdles  $2\frac{3}{4}$  yards long. How many hurdles are required?

4. How many yards of paper, 27 inches broad, will be required to cover a wall  $3\frac{1}{2}$  yards high and  $5\frac{1}{4}$  yards broad?

5. Find the greatest common factor and the least common multiple of 336, 468 and 792.

6. Simplify :

$$(i) \frac{\frac{2}{2\frac{1}{4}} - \frac{1\frac{3}{4}}{2}}{\frac{2}{2\frac{1}{4}} \text{ of } \frac{1\frac{3}{4}}{2}} \div \left( \frac{2}{2\frac{1}{4}} + \frac{1\frac{3}{4}}{2} \right);$$

$$(ii) \frac{\frac{39}{713}}{55 \times \frac{91}{115} \times \frac{24}{341}}.$$

7. A picture, 18 inches broad and  $10\frac{1}{2}$  inches deep, is to be photographed on a reduced scale, so that the breadth of the photograph may be  $7\frac{1}{2}$  inches. Find the depth of the photograph.

8. Simplify :

$$(i) (8.47 + .016 - .0028) \times (.75 + .075 - .8125);$$

$$(ii) 3.4399 \div .435.$$

9. Express .0390625 of a day (24 hours) in minutes and seconds.

If 8 metres are equal to 315 inches, express one metre as a decimal fraction of a yard.

10. In a school of 1200 the number presented for an examination was 20 per cent. of the whole, while the numbers passing in the first and second classes were respectively  $12\frac{1}{2}$  and  $32\frac{1}{2}$  per cent. of those presented. Find the number presented and the number passing in each class.

11. A customer deposits £100 in a bank on 31st January, £150 on 30th April, and £125 on 31st July. What interest is due to him on 31st December, the rate being  $2\frac{1}{2}$  per cent. per annum, and one-twelfth of a year's interest being allowed for each calendar month?

## LII.

*Scotch Leaving Certificate, 1897.*

*Higher Grade.*

1. Find the values of :

(i)  $\frac{13}{15}$  of 3 furlongs, 4 chains, 3 yards, 2 feet ;

(ii) 1·9375 of 10 cubic yards.

2. A can do a piece of work in 14 days of 9 hours, and B can do the same piece in 12 days of 7 hours. How long will they take to do it, working together for 8 hours a day ?

3. Give the two rules for the determination of leap year. On what day will a child, born 1st June 1897, have lived exactly 4000 days ?

4. The average passenger fare on a railway is  $1\frac{1}{4}d.$  a mile, the average journey is 12 miles, and the average weekly revenue is £710,306. Find the average number of passengers in a week.

5. Simplify the expressions :

(i)  $\left(\frac{4844}{5536} + \frac{7623}{8316}\right) \div 1\frac{19}{24}$  ;

(ii)  $\cdot 61936 \times 9\cdot 6872 \times 20\cdot 83$ .

6. The sum of £189. 6s. 9d. is to be divided between 7 men, 11 women, 5 boys, and 6 girls, so that for every 5s. a man receives a woman may get 2s. 11d., and for every 3s. 6d. a woman receives a boy may get 2s. 6d. and a girl 1s. 6d. Find how much each person receives.

7. What sum will amount to £8334. 18s. in 3 years at 5 per cent. compound interest ?

8. A square enclosure is surrounded by a roadway whose breadth is one-eleventh of the side of the enclosure. The area of the roadway is 1 acre, 2 roods, 28 square poles, 5 square yards. Find the length of the side of the enclosure in feet.

9. A man invests in Government stock paying  $2\frac{3}{4}$  per cent. interest, and finds that after paying 6d. in the pound income tax, his net income is exactly  $2\frac{1}{2}$  per cent. of the sum invested. At what price did he purchase the stock ?

## LIII.

*Scotch Leaving Certificate, 1898.**Lower Grade.*

1. Divide thirty-nine million one hundred and sixty-nine thousand five hundred and seven by nine thousand seven hundred and eighty.

2. Resolve into prime factors 3234000 and 151200, and find their least common multiple as a product of prime factors.

3. If a bicyclist ride a mile in 2 minutes, 12 seconds, how long will he take to ride a kilometre, assuming that a metre is 3·29 feet?

4. A room 27 feet long requires 52 square yards of carpet to cover the floor; find the breadth of the room.

5. If 3 per cent. be gained by selling an article for £1. 14s. 4d., at what price must it be sold to gain  $5\frac{3}{4}$  per cent.?

6. Extract the square root of  $37\frac{36}{49}$ .

7. Simplify :

$$(i) \quad \frac{\left(\frac{1}{12} + \frac{1}{16}\right) \text{ of } \frac{5}{14} - \frac{3}{8} + \left(\frac{3}{5} \text{ of } \frac{1}{4}\right)}{\left(\frac{1}{12} - \frac{1}{16}\right) \text{ of } \frac{4}{21} - \frac{3}{8} - \left(\frac{3}{5} \text{ of } \frac{1}{4}\right)};$$

$$(ii) \quad \frac{4}{7} \text{ of } \frac{5}{8} \text{ of } \frac{3}{4 + \frac{5}{8}} - \frac{1}{1 + \frac{1}{4 - \frac{3}{14}}}.$$

8. Express as vulgar fractions in their lowest terms :

$$(i) \quad \frac{(\cdot 36 \times \cdot 25) + 4 \cdot 05}{4 \cdot 2 \times \cdot 024 \div \cdot 02}; \quad (ii) \quad \cdot 375 \times \cdot 8 \times \cdot 36 \times \cdot 772.$$

9. A takes 10 days to do a piece of work, which B can do in 8 days. If A works at it for  $3\frac{1}{2}$  days, and is then joined by B, how long will they take to finish it?

10. A bankrupt's debts amount to £9089. 1s. 4d., and his estate realises £5254. 12s. 4d.; what can he pay in the pound?

11. A gallon of water weighs 10 lbs. avoirdupois, and a cubic foot of water 997 ounces; find how many gallons are contained in a cistern 12 feet long, 10 feet broad, and 6 feet deep.

12. What sum will amount to £411. 17s. 9d. in 7 years at  $3\frac{1}{2}$  per cent. simple interest?

### LIV.

*Scotch Leaving Certificate, 1898.*

*Higher Grade.*

1. If I can buy 8 apples and 21 oranges for 9d., and 4 apples and 12 oranges for 5d., what are the prices of apples and oranges?

2. A grocer buys sugar at 14s. per cwt. and sells it at 2d. per lb.; if he lose  $2\frac{1}{2}$  lbs. out of each cwt., find his gain per cent. on his outlay.

3. The sides of a rectangle are, correct to three decimal places, 8.127 and 13.463 inches; find the area, correct to two decimal places, and explain why the result cannot be trusted as correct to more than two decimal places.

4. A closed packing case measures externally 32,  $25\frac{1}{2}$ , and  $15\frac{1}{2}$  inches, the wood being three-quarters of an inch thick, and the weight is 75 lbs.; find the weight of a cubic foot of the same wood.

5. A man holding £4850 four per cent. Stock, sells it at 133, and invests the proceeds in  $2\frac{1}{4}$  per cent. Stock at 104 $\frac{1}{2}$ . Find the change in his income, assuming that there is no charge for brokerage.

6. Simplify:

$$(i) \quad \frac{\frac{3}{5} \left( 1 - \frac{11}{21} \text{ of } 1\frac{1}{5} \right)}{\frac{3}{4} \text{ of } 3\frac{1}{5} + \frac{1}{10}} \div \frac{\frac{1}{6} \text{ of } .0015 \div .009}{2\frac{4}{9} \text{ of } 10 - .025 \text{ of } 5\frac{5}{9}};$$

$$(ii) \quad .85714\dot{2} \text{ of } 1 \text{ cwt.} + 3.458\dot{3} \text{ of } 1 \text{ lb.} + 8.6 \text{ of } 1 \text{ oz.}$$

7. What is meant by the present worth of a sum of money?

If £9645. 1s. 6d. is due three months hence, how much should be paid now in its place, assuming that interest is obtainable at 5 per cent. per annum?

8. If a metre be 3·29 feet, how many miles will a man walk in 9 hours 46 minutes 40 seconds at the rate of 6 kilometres an hour?

9. In what cases can a vulgar fraction be expressed as a terminating decimal fraction?

Express  $\frac{1}{19}$  as a circulating decimal without performing more division than is necessary.

10. A train 66 yards long overtakes a person walking along the line at the rate of 4 miles an hour, and passes him in  $7\frac{1}{2}$  seconds; how long will it take to pass a person walking along the line in the opposite direction at the rate of 3 miles an hour?

## LV.

*Scotch Leaving Certificate, 1899.*

*Lower Grade.*

1. Multiply £374. 13s. 6d. by 279.

2. The National Debt on 31st March, 1890, amounted to six hundred and ninety million six hundred and sixty-four thousand pounds, and has since then been gradually reduced at the average rate of seven million nine hundred and sixty-five thousand pounds a year. If this rate be maintained till 31st March, 1900, state in words the amount of the debt at that date.

3. Resolve 1800, 1225, and 945 into their prime factors, and find their least common multiple.

4. A railway covers ground to the breadth of 22 yards; how many acres will be covered by a mile of the railway?

5. Simplify:

$$(i) \quad \frac{4}{7} + \frac{13}{15} - \frac{27}{35}; \quad (ii) \quad \frac{561}{935} - \frac{524}{917}.$$

6. I read  $\frac{3}{8}$  of a book on one day and  $\frac{4}{5}$  of the remainder on another day. If there were now thirty pages unread, how many pages did the book contain?

7. Express  $\frac{7}{8}$ ,  $\frac{14}{125}$ ,  $\frac{4}{9}$ ,  $\frac{6}{13}$  as decimal fractions, and  $\cdot 625$ ,  $\cdot 312$ ,  $\cdot 3$ ,  $\cdot 03\bar{7}$  as vulgar fractions in their lowest terms.

8. Simplify :

$$(i) \frac{\frac{4}{7} \text{ of } \frac{5}{9}}{\frac{2}{13} \text{ of } 8\frac{1}{2}} \div \frac{1\frac{1}{3} - \frac{8}{9}}{10\frac{3}{4} - 6\frac{1}{2}}; \quad (ii) \frac{2\cdot34 - \cdot0025}{74\cdot8 \times \cdot025}.$$

9. Express (i) £2. 1s. 3d. as a vulgar fraction of £2. 11s. 4d.

(ii) 5 cwt. 2 qrs. 7 lbs. as a decimal fraction of a ton.

10. A man mixes 1 cwt. of tea at 1s. 7d. per lb. with 2 cwt. 14 lbs. at 2s. per lb.; what is the value of 5 lbs. of the mixture?

11. If a metre be 39·37 inches, express an inch in millimetres correct to four significant figures.

12. The rate of bank interest is raised from  $3\frac{1}{4}$  to  $3\frac{1}{2}$  per cent., and a depositor finds that his interest is increased by 1s.  $5\frac{1}{2}$ d. per month; find the amount of his deposit.

## LVI.

*Scotch Leaving Certificate, 1899.*

*Higher Grade.*

1. A sum of £10,000 is to be divided between several claimants, so that some are to receive £80. 12s. 10d., and the others £80. 12s. 11d.; how many persons will receive each of those amounts?

2. A man endeavoured to paper a wall with postage stamps, of which he had 38,080, measuring  $\frac{11}{15}$  of an inch by  $\frac{13}{17}$  of an inch; if the wall was 17 ft. 4 in. by 9 ft. 2 in., what fraction of its surface would the stamps cover?

3. If money invested in the  $2\frac{3}{4}$  per cents. bring in a return of  $2\frac{2}{5}$  per cent., find the price of the stock.

4. An oblong field is three times as long as it is broad, and its area is 12 acres; find the cost of fencing it at 2s. 4d. a yard, neglecting fractions of a yard.

5. Give the rule for reducing to a vulgar fraction a decimal fraction which contains a recurring period, and prove the rule in the case of  $\cdot 03\bar{4}6$ .

Simplify :

$$\begin{array}{r} \cdot 6\bar{8} \times \cdot 60\bar{8} \\ \cdot 0\bar{6}8 \times \cdot 060\bar{8} \end{array}$$

6. Two sums of £1000 are deposited to accumulate at 4 per cent. per annum compound interest, but in one case the interest is payable yearly, and in the other half-yearly. Find, correct to the nearest penny, how much the interest received in the second case will exceed that received in the first case at the end of two years.

7. A cubic centimetre of mercury weighs approximately 13.596 grammes; find, to three decimal places, the weight of the mercury in a bottle that holds approximately 49.974 cubic centimetres, and show that your result may have an error of as much as .03 grammes.

8. A train, approaching a station at the rate of 25 miles an hour, passes over two fog signals placed half a mile apart; find the interval between the times at which their reports are heard at the station, sound travelling at the rate of 1100 feet per second.

9. Give the rules for ascertaining whether a given number is divisible by 9 and 11 respectively.

Show that if a number be divided into pairs of digits beginning on the right, the number will be divisible by 99 if the sum of the numbers formed by each pair of digits be divisible by 99.

(For example, 13470534 is a multiple of 99, since

$$13 + 47 + 5 + 34 = 99.)$$

## LVII.

*Scotch Leaving Certificate, 1900.**Lower Grade.*

1. When a certain number is divided by 967 the quotient is 475 and the remainder is 288; find the number.

2. A man's annual income is £483. 17s. and his average daily expenditure during a certain year is £1. 2s. 4d., how much does he save that year?

3. Find the value of 8 tons 13 cwt. 24 lbs. at £16. 16s. the ton.

4. A bankrupt's property, after all expenses are paid, amounts to £849, while his debts are £4075: how much will a creditor, to whom he owes £500, receive?

5. Find the simple interest on £1804. 3s. 4d. for 73 days at  $4\frac{1}{2}$  per cent. per annum.

6. The circumferences of the two wheels of a bicycle are 84 and 88 inches: before starting a mark is made at the lowest point of each: how far will the bicycle travel before the marks reach the ground simultaneously?

7. (i) Explain the meaning of  $\frac{2}{5}$  and  $\frac{6}{15}$ ; and show that they are equal to each other.

(ii) Simplify the fractions  $\frac{42030}{116750}$ ,  $\frac{45769}{87727}$ .

8. Multiply  $\frac{6}{\frac{3}{5} + \frac{7}{6} + \frac{13}{10}}$  by  $\frac{4}{5} + \frac{7}{9} + \frac{13}{15}$ .

Divide 253·53549 by ·0507.

9. State as clearly as you can remember how many inches there are in a metre, and how many grains in a gramme.

Express in kilogrammes the weight of a kilometre of uniform wire, 25 centimetres of which weigh 41 decagrammes.

10. A room is 20 feet long and 16 feet 6 inches broad, and it is required to cover all of it, except a margin of 18 inches, with carpet; the roll of carpet is 2 feet 3 inches broad, and cost 4s. 6d. a yard: find the cost of the carpet required.

### LVIII.

*Scotch Leaving Certificate, 1900.*

*Higher Grade.*

1. Find the highest common factor of 7163 and 7429. Express each of those numbers as the product of three prime numbers.

2. During a recent year, the production of gold was valued at £43,213,000; if one sovereign contains 123·27 grains of gold, and there are 7000 grains in one pound avoirdupois, find the weight in tons of this output, correct to two decimal places.

3. Determine, without unnecessary calculation, the number of millions (correct to the nearest million) in the product of 719386 and 28763.

4. One square contains three times the area of another square; if one side of the larger square be 5 inches, find that of the smaller in inches correct to four significant figures.

5. Express  $\cdot 0463$  of £7 +  $\cdot 256$  of 14s. 6d. as a decimal fraction of £15.

Taking a metre as 39·37 inches, express in yards the difference between 5 miles and 8 kilometres.

6. An agent buys 17400 tons of coal at 21s. 6d. a ton, and receives a certain percentage of the price as his commission; if the whole amount paid be £18954. 8s., find the rate per cent. at which the commission is allowed.

7. A trustee has a sum of money to invest, and is doubtful whether to buy  $2\frac{3}{4}$  per cent. Consols at  $104\frac{1}{2}$ , or  $3\frac{1}{2}$  per cent. India Stock at  $108\frac{1}{2}$ , brokerage included in both cases; find what rate of interest would be obtained in each case, and calculate the amount to be invested when the difference of the incomes is 25 guineas.

8.  $A$  holds a bill from  $B$  for £1052. 6s. payable  $9\frac{1}{2}$  months hence, and  $B$  holds a bill from  $A$  for £1596. 8s. payable 7 months hence; they agree to cancel both bills by  $A$ 's giving  $B$  a new bill payable 3 months hence: determine the amount for which this bill should be drawn, the rate of interest being 4 per cent. per annum.

9. Prove that every proper fraction either reduces to a terminating decimal, or to a circulating decimal in which the number of the circulating figures is less than the denominator of the fraction.

Find the circulating period of  $\frac{4}{13}$ , and write down the other proper fractions with 13 as denominator, whose periods consist of the same figures in the same circular order.

## APPENDIX.

*Containing miscellaneous questions in Logarithms and Mensuration.*

\*

THE following list of numerical constants will be found useful for reference.

(1) *Logarithms of the first few prime numbers.*

log 2 = .3010300.	log 11 = 1.0413927.
log 3 = .4771213.	log 13 = 1.1139434.
log 7 = .8450980.	log 17 = 1.2304489.

When certain logarithms are given in any question, no other logarithms should be used in the solution.

(2) *Approximate square roots.*

$$\sqrt{2} = 1.414. \quad \sqrt{3} = 1.732.$$

(3) *Approximations to functions of  $\pi$ .*

$$\pi = 3.141592653.....,$$

but for all practical purposes it is sufficient to take  $\pi = 3.1416$ , and this value will always be taken unless the contrary is expressly stated in the question.

It is useful to notice that  $31416 = 8 \times 3 \times 7 \times 11 \times 17$ .

Sometimes it is more convenient to use  $\pi = \frac{22}{7}$ .

$$\sqrt{\pi} = 1.772. \quad \sqrt[3]{\pi} = 1.465.$$

$$\frac{1}{\pi} = .3183. \quad \frac{1}{\sqrt{\pi}} = .5642. \quad \sqrt[3]{\frac{3}{4\pi}} = .620.$$

## COMPOUND INTEREST.

If  $M$  is the amount of  $P$  pounds in  $n$  years, then  $M = PR^n$ , where  $R = 1 + r$ , and  $r$  is the interest on one pound for one year at the given rate per cent.

## MENSURATION.

*List of Formulæ.*

## I. Plane Figures.

(1) Area of a *Parallelogram* = base  $\times$  altitude.

(2) Area of a *Triangle* =  $\frac{1}{2}$  (base  $\times$  altitude),

or

Area =  $\frac{1}{2}$  (product of two sides)  $\times$  (sine of included angle).

Area in terms of the sides =  $\sqrt{s(s-a)(s-b)(s-c)}$ ,

where  $2s = a + b + c$  = perimeter of the triangle.

(3) Area of a *Trapezium* =  $\frac{1}{2}$  (sum of parallel sides)  $\times$  (distance between them).

(4) Area of *any Polygon* = the sum of the areas of the triangles into which it can be subdivided.

(5) Area of *Regular Polygon* of  $n$  sides =  $\frac{na^2}{4} \cot \frac{\pi}{n}$ , where  $a$  is the length of each side.

(6) *Circle* of radius  $r$ .

Circumference =  $2\pi r$ . Area =  $\pi r^2$ .

(7) *Sector and Segment* of a circle of radius  $r$ .

If the angle at the centre is  $n$  degrees or  $\theta$  radians,

Area of Sector =  $\frac{n}{360} \pi r^2 = \frac{1}{2} r^2 \theta$ .

• Area of *Segment* = area of a sector – area of a triangle

$$= \frac{1}{2} r^2 \theta - \frac{1}{2} r^2 \sin \theta,$$

where  $\theta$  is the number of radians subtended at the centre by the chord of the segment.

## II. Surfaces and Volumes of Solids.

(1) *Sphere whose radius is r.*

$$\text{Surface} = 4\pi r^2.$$

$$\text{Volume} = \frac{4}{3} \pi r^3.$$

Curved surface of a *Zone of a sphere* contained between two parallel planes =  $2\pi r h$ , where  $h$  is the distance between the parallel planes.

Observe that this result is the same from whatever part of the sphere the zone is taken, provided that the *thickness* remains the same.

If one of the planes is tangential, the solid figure then cut off is a *Segment* of a sphere. Thus the curved surface of a segment of a sphere is  $2\pi r h$ , where  $h$  = the height of the segment, and  $r$  is the radius of the *sphere* from which it is cut.

$$\text{Volume of Zone} = \frac{\pi h}{6} \{3(r_1^2 + r_2^2) + h^2\},$$

where  $h$  is the height, and  $r_1, r_2$  the radii of the two ends.

If we put  $r_2 = 0$ , we obtain

$$\text{Volume of Segment} = \frac{\pi h}{6} (3r_1^2 + h^2).$$

(2) *Prism.*

Surface of *Prism* = sum of parallelograms which form the faces + areas of the two ends.

$$\text{Volume of Prism} = (\text{area of base}) \times \text{height}.$$

(3) *Cylinder* [Particular case of prism when the ends are circular].

Convex surface =  $2\pi rh$ , where  $h$  is the height, and  $r$  is the radius of the base.

$$\text{Volume} = (\text{area of base}) \times \text{height} = \pi r^2 h.$$

These two formulæ are true whether the ends of the cylinder are perpendicular to the axis or not, if for "height" we substitute "distance between the centres of the two ends," and for "base" the "section perpendicular to axis."

(4) *Pyramid*.

Surface = sum of triangular faces + area of base.

$$\text{Volume} = \frac{1}{3} (\text{area of base}) \times \text{height}.$$

*Frustum of Pyramid*, cut off between two parallel planes.

Volume =  $\frac{h}{3} \{E_1 + \sqrt{E_1 E_2} + E_2\}$ , where  $E_1$ ,  $E_2$  are the areas of the ends, and  $h$  is the distance between them.

(5) *Right Circular Cone* (Particular case of pyramid when the base is circular).

$$\begin{aligned} \text{Convex surface} &= \frac{1}{2} (\text{circumference of base}) \times \text{slant side} \\ &= \pi r l, \end{aligned}$$

where  $r$  is the radius of the base, and  $l$  is the length of the slant side.

$$\text{Volume} = \frac{1}{3} (\text{area of base}) \times \text{height} = \frac{1}{3} \pi r^2 h.$$

$$\begin{aligned} \text{Volume of Frustum of Cone} &= \frac{h}{3} \{E_1 + \sqrt{E_1 E_2} + E_2\} \\ &= \frac{\pi h}{3} \{r_1^2 + r_1 r_2 + r_2^2\}, \end{aligned}$$

where  $h$  is the height,  $E_1$ ,  $E_2$  are the areas, and  $r_1$ ,  $r_2$  are the radii of the two ends.

Convex surface of *Frustum of Cone*

$$= \frac{1}{2} (\text{sum of circumferences of ends}) \times \text{slant side.}$$

### III. Similar Figures and Solids.

1. The areas of similar figures are to one another as the squares of *any corresponding lengths*. Compare Euclid vi. 19, 20.

Thus if  $\Delta_1, \Delta_2$  are the areas of two triangles whose bases are  $b_1, b_2$ ; whose altitudes are  $h_1, h_2$ ; and whose inscribed circles have radii  $r_1, r_2$ ; then

$$\frac{\Delta_1}{\Delta_2} = \frac{b_1^2}{b_2^2} = \frac{h_1^2}{h_2^2} = \frac{r_1^2}{r_2^2}.$$

2. The surfaces of similar solids are to one another as the squares of *any corresponding lengths*.

Thus if  $S_1, S_2$  denote the surfaces of two cubes whose edges are  $a_1, a_2$ ; and whose diagonals are  $d_1, d_2$ ; then

$$\frac{S_1}{S_2} = \frac{a_1^2}{a_2^2} = \frac{d_1^2}{d_2^2}.$$

3. The volumes of similar solids are to one another as the cubes of *any corresponding lengths*.

Thus if a cone is cut by two parallel planes whose distances from the vertex are  $h_1, h_2$ , and if  $V_1, V_2$  are the volumes of the cones cut off; then

$$\frac{V_1}{V_2} = \frac{h_1^3}{h_2^3}; \text{ whence } \frac{V_1 - V_2}{V_1} = \frac{h_1^3 - h_2^3}{h_1^3}.$$

Here  $V_1 - V_2$  is the volume of a frustum the perpendicular distance between whose ends is  $h_1 - h_2$ .

## LOGARITHMS AND MENSURATION.

### EXERCISE I.

1. Find correct to a farthing the present value of £10000 due 8 years hence at 5 per cent. per annum compound interest: having given the values of  $\log 2$ ,  $\log 3$ ,  $\log 7$ , and

$$\log 67683 = 4.8304796, \quad \log 67684 = 4.8304860.$$

2. Find  $\log 10 \frac{2}{25}$ , and calculate to six decimal places the value of

$$\sqrt[3]{\left(\frac{294 \times 125}{42 \times 32}\right)^2};$$

having given the values of  $\log 2$ ,  $\log 3$ ,  $\log 7$ , and

$$\log 90762 = 4.9579041, \quad \log 90763 = 4.9579088.$$

3. Find a fourth proportional to the fifth power of 11, the fourth power of 7, and the fifth power of 5; having given the values of  $\log 2$ ,  $\log 7$ ,  $\log 11$ , and

$$\log 46588 = 4.6682741, \quad \log 46589 = 4.6682834.$$

4. Calculate by duodecimals the area of a rectangle whose sides are 8 ft. 9 in. 10 pts. and 5 ft. 6 in. 7 pts.

5. The area of a triangle is 6 ac. 2 ro. 8 po., and a perpendicular from one angle on the base measures 524 links: find the length of the base in chains.

6. A field is in the form of a trapezium; its parallel sides are 10 chains 30 links and 7 chains 70 links in length, and the distance between them is 7 chains 50 links: find the acreage.

7. Find the number of square poles in a roadway 5 yards wide round a circular pond 120 yards in diameter.  $\left(\pi = \frac{22}{7}.\right)$

8. The circumference of a circle is one mile, find its area in acres.

9. The circumference of a circle is 18·8496 inches, find the area of an equilateral triangle inscribed in it correct to the hundredth part of a square inch.

10. The sides of a triangular field are 300, 400 and 500 yards; if a belt 50 yards wide is cut off the field what are the sides of the interior triangle, and what is the area of the belt?

### EXERCISE II.

1. Given the values of  $\log 2$ ,  $\log 3$ ,  $\log 7$ ,  $\log 11$ , calculate

$$\log \cdot 0021, \log (147)^2, \text{ and } \log \sqrt[5]{\frac{2\sqrt{7}}{3\sqrt{11}}}.$$

2. Given  $3^x = 7175\cdot37$ , find the value of  $x$ ; having given the value of  $\log 3$ , and

$$\log 71\cdot753 = 1\cdot8558401, \quad \log 71\cdot754 = 1\cdot8558461.$$

3. Find the amount of £5500 in 15 years at 5 per cent. compound interest; having given the values of  $\log 2$ ,  $\log 3$ ,  $\log 7$ , and  $\log 1\cdot1434 = 0\cdot0581982$ ,  $\log 1\cdot1435 = 0\cdot0582362$ .

4. Find in acres the area of a triangle whose sides are 25, 20 and 15 chains.

5. The distance between two towns is 54 miles, and the distance between their places on a map is  $6\frac{3}{4}$  inches; what area of country is represented by a circle on the map of one inch radius?

6. Calculate by duodecimals the cubic content of a rectangular block of marble 7 ft. 5 in. 7 pts. long, 4 ft. 2 in. wide, and 3 ft. 4 in. 7 pts. high.

7. Find the circumference of a circle whose area is equal to that of a square the side of which is 320 yards in length.

8. The sides of a triangle are 39, 42, 45 feet: find the length of the perpendicular from the greatest angle on the opposite side.

9. If a room is 40 ft. long by 20 ft. broad and contains 12800 cub. ft.; what addition will be made to its cubic contents by throwing out a semicircular bow at one end?

10. An English Imperial gallon is a measure which will hold 10 lbs. Avoir. of pure water. A cubic foot of pure water weighs 997·137 oz. Avoir.; the French litre is a cubic decimètre, that is, a cube on a side of 3·937 inches: find to two places of decimals how many litres there are in a gallon.

### EXERCISE III.

1. Given  $\log 2$ , find the value of  $x$  to three places of decimals from the equation

$$8^x \cdot 125^{2-x} = 2^{4x+3} \cdot 5^x.$$

2. Given  $\log 2$ ,  $\log 3$ ,  $\log 7$ , find in what time a sum of money will treble itself at 5 per cent. compound interest.

3. Given  $\log 3$ ,  $\log 32 = 1\cdot50515$ ,  $\log 33 = 1\cdot51851$ ; find the value of

$$\sqrt[9]{\frac{4\cdot5 \times \cdot001 \times \sqrt[3]{9}}{32^5 \times (\cdot0005)^7}}.$$

4. The perimeters of a circle, a square and an equilateral triangle are each of them one foot; find the area of each of these figures to the nearest hundredth of a square inch.  $\left(\pi = \frac{22}{7}\right)$

5. The sides of a triangular field are respectively 10, 8, 12 chains: find the acreage of the field, and the perpendicular distance of its longest side from the opposite corner.

6. Find by duodecimals the cubic content of a block of stone 4 ft. 7 in. long, 4 ft. 2 in. 5 pts. wide, and 2 ft. 7 in. 6 pts. high.

7. Each side of a rhombus is 120 yards, and one of its angles is  $60^\circ$ ; find the area of the rhombus in acres to two decimal places.

8. How many cubic inches of iron are there in a garden roller, which is half an inch thick, with an outer circumference of  $5\frac{1}{2}$  feet, and a width of  $3\frac{1}{2}$  feet?  $\left(\pi = \frac{22}{7}\right)$

9. If 30 cubic inches of gunpowder weigh one pound, what weight of gunpowder will be required to fill a cylinder of 8 inches internal diameter, and with a length of  $2\frac{1}{2}$  feet?

10. A solid metal sphere, 6 inches in diameter, is formed into a tube 10 inches in external diameter and 4 inches in length: find the thickness of the tube.

**EXERCISE IV.**

1. Given  $\log 21544 = 4.3333263$ ,  $\log 2.1545 = .3333465$ , find to 5 places of decimals the seventh root of  $215.4434$ .

2. Find in how many years a sum of money will double itself at 8 per cent. per annum compound interest, payable half-yearly; given  $\log 2$ , and  $\log 104 = 2.01703$ .

3. Calculate to 6 places of decimals the value of

$$\frac{\left(330 \times \frac{1}{49}\right)^4}{\sqrt[3]{22 \times 70}};$$

having given  $\log 2$ ,  $\log 3$ ,  $\log 7$ ,  $\log 11$ , and  $\log 17814 = 4.2507614$ , diff. for 1 = 244.

4. The circumference of a circular field is 273 yards: if the field is worth £67. 12s., find the value of a circular field whose circumference is 294 yards.

5. Find the length of the edge of a cubical block of stone containing 46 c. yds. 513 c. in., and the number of square inches in its entire surface.

6. Water is poured into a cylindrical reservoir 20 feet in diameter at the rate of 400 gallons a minute: assuming a gallon of water to measure 277.25 cub. in., find the rate at which the surface of the water rises in the reservoir.

7. The sides of a triangle are in the ratio of 13, 14, 15, and the perimeter is 280 yards: how many square feet does the triangle contain?

8. Find the weight of a hollow sphere of metal whose inside diameter is 18 inches and the thickness 2 inches; given  $\pi = \frac{22}{7}$ , and the weight of a cubic foot of the metal = 7776 oz.

9. The length of a trough is 15 feet and its ends are equilateral triangles: it contains 173200 cubic feet of water: required the depth.

10. It is required to cover a piece of ground 80 feet square by a pyramidal tent 30 feet in perpendicular height: find the cost of the requisite quantity of canvas at  $4\frac{1}{2}d.$  per square yard.

**EXERCISE V.**

1. Given  $\log 2$  and  $\log 3$ , find what would be the logarithm of 180 if the base were 12.

2. Given the mantissae of the logarithms of the following numbers :

2289, 343, 1092, 854, 855677,

to be .3596458, .5352941, .0382226, .9314579, .9323102;

find the value of  $\sqrt{2289 \times 343 \times 1092 \times 854}$ .

3. Given  $\log_a b = c$ , find the logarithm of the square root of  $a$  when the base is the cube root of  $b$ .

4. Find the area of a triangle whose sides are 222, 350, 352 yards.

5. Find the cost of making a moat round a circular island, at 2s. 6d. per square yard; the diameter of the island being 525 feet, and the breadth of the moat 21 ft. 6 in.  $\left(\pi = \frac{22}{7}\right)$

6. Find the total surface of a hollow cylinder whose external and internal diameters are 12 and 8 inches respectively, and whose height is 1 foot.  $\left(\pi = \frac{22}{7}\right)$

7. How many square yards of canvas will be necessary to form a conical tent, whose perpendicular height is 10 ft., and diameter on the ground 21 ft. ?  $\left(\pi = \frac{22}{7}\right)$

8. Find the cost of a piece of marble in the form of a frustum of a cone; the diameters of the two ends being 11 ft. 8 in. and 8 ft. 2 in., and the slant height 18 ft. 5 in., and the value of a cubic foot of marble being 12s.  $\left(\pi = \frac{22}{7}\right)$

9. A sphere, whose radius is  $3\frac{1}{2}$  in., is enclosed in a hollow cylinder of the same radius, whose length is equal to its circumference: how many cubic inches are there in the remaining part of the cylinder?  $\left(\pi = \frac{22}{7}\right)$

10. Two hundred and seventeen cubic inches of glass are blown into the form of a hollow sphere which will hold  $1\frac{3}{4}$  gallons: find the thickness of the sphere, supposing that a cubic foot contains  $6\frac{1}{4}$  gallons.

## EXERCISE VI.

1. Given  $\log 637 = 2.8041394$ ,  $\log 13 = 1.1139434$ , find  $\log 7$ ; and given  $\log 12 = 1.0791812$ ,  $\log 18 = 1.2552725$ , find  $\log 2$  and  $\log 3$ .

2. How many positive integers are there whose logarithms to base 12 have 3 for characteristic?

3. If the number of persons born in any year be  $\frac{1}{4}$ <sup>th</sup> of the whole population at the commencement of the year, and the number of those who die  $\frac{1}{80}$ <sup>th</sup> of it, find in how many years the population will be doubled; having given

$$\log 2 = .301030, \log 180 = 2.255272, \log 181 = 2.257679.$$

4. Find by duodecimals the contents of a cistern 5 yds. 2 ft. 3 in. 7 pts. long, 4 yds. 5 in. 9 pts. broad and 10 ft. 3 pts. deep, expressing the answer in cubic yards, feet, inches and fractions of an inch.

5. Find the diameter of a circle, the area of which is equal to a square whose side is 25 feet.

6. Find the weight of water in a hollow sphere whose internal diameter is 3 ft. 6 in.: given that a cubic foot of water weighs 1000 oz.

7. Find the slant height of a cone, whose volume is  $19\frac{1}{4}$  cubic feet, and base diameter  $3\frac{1}{2}$  ft.  $\left(\pi = \frac{22}{7}\right)$ .

8. Find the volume of a prism on a triangular base; the sides of the base being 51, 40, 13 inches and the height 58 inches.

9. A hollow iron cylinder, of which the internal radius is 3 in. and the thickness 2 in., is cased with wood an inch thick. If the weights of equal volumes of the iron and wood are as 11 : 2, compare the weights of the iron cylinder and wooden case.

10. A tower 24 ft. square is surmounted by a pointed roof, which is 5 ft. high; how many tiles, 9 in. by 4 in., will be required to cover it, supposing that one-fourth of each tile is overlapped or broken off?

**EXERCISE VII.**

1. Find, without the use of logarithm tables, the value of

$$\sqrt{\frac{3 \log 1728}{1 + \frac{1}{2} \log 36 + \frac{1}{3} \log 8}}$$

2. Find by logarithms the value of  $\frac{403.09 \times .002317 \times 17}{18.543}$  ;

given  $\log 4.0309 = .6054020$ ,  $\log 2.317 = .3649260$ ,  
 $\log 17 = 1.2304489$ ,  $\log 185.43 = 2.2681800$ ,  
 $\log 8.5624 = .9325955$ ,  $\text{diff.} = 51$ .

3. Solve the equation  $\log 3^{x-2} = 2.404691352$ , having given  $\log 3 = .4771213$ .

4. Find the acreage of a triangular field whose sides are 1360, 1500, 1540 links.

5. The diameters of the wheels of a bicycle are 52 and 15 inches respectively; determine how many more revolutions the small wheel would make than the large wheel in a distance of 13 miles.  $\left(\pi = \frac{22}{7}\right)$

6. If a cylinder of lead 1 ft. long and 1 inch in diameter weighs 4 lbs., find the weight of a lead pipe 30 yards long, whose outside and inside diameters are  $1\frac{1}{2}$  inches and 1 inch respectively.

7. A cube and a sphere being of equal volume, find the ratio of the radius of the sphere to the side of the cube.

8. Find the volume of a right cone, the height of which is 15 ft., and the circumference of the base is 14 ft.  $\left(\pi = \frac{22}{7}\right)$

9. The external diameter of an iron roller is 1 ft. 9 in., its thickness is  $1\frac{1}{2}$  in., and width 5 ft.: find its cost, given that a cubic foot of iron weighs 464 lbs., and that iron costs 16s. a cwt. Also find how many times the roller would turn round in rolling 5 acres of land.  $\left(\pi = \frac{22}{7}\right)$

10. Three hemispherical bowls, of equal thickness and of the same material, are made to fit one inside another, and the interior diameter of the smallest is twice the thickness of each: compare their weights.

**EXERCISE VIII.**

1. Find  $\log 210$ ,  $1\frac{1}{6} \times \log \cdot 182$ , and  $\log \sqrt{13} \sqrt{5} \div \sqrt{7}$ ;  
 given  $\log 2 = \cdot 3010300$ ,  $\log 3 = \cdot 4771213$ ,  $\log \cdot 7 = \bar{1} \cdot 8450980$ ,  
 $\log 1 \cdot 3 = \cdot 1139434$ .
2. Given  $\log 2$ , solve the equation  
 $\log (\cdot 125)^{x-4} = \cdot 0270927$ .
3. A train starts with velocity  $\cdot 001$  ft. per second, and at the end of each second its velocity is greater by one-third than at the end of the preceding second; find the rate of the train in miles per hour at the end of 25 seconds, given  
 $\log 2$ ,  $\log 3$ , and  $\log 1328 \cdot 8 = 3 \cdot 1234596$ ,  $\log 1328 \cdot 9 = 3 \cdot 1234923$ .
4. Find by duodecimals the area of the floor of a room 46 ft. 1 in. 9 pts. long and 26 ft. 5 in. 8 pts. wide, expressing the answer in square feet, inches, and fraction of an inch.
5. How many sovereigns could be made out of a bar of gold 33 inches long,  $5\frac{1}{4}$  inches broad, and  $3\frac{1}{5}$  inches deep, supposing the diameter and average thickness of a sovereign to be  $\cdot 84$  in. and  $\cdot 05$  in. respectively?  $\left(\pi = \frac{22}{7}\right)$
6. The sides of a triangle are in the ratio of 5, 5, and 6: if its area is 588 sq. yds., find the length of each side.
7. What is the solid content of a sphere when its surface is equal to that of a circle 4 feet in diameter?
8. A circle, an equilateral triangle, a square and a hexagon each have the same perimeter, namely 120 feet; find their areas, assuming  $\pi = \frac{22}{7}$ .
9. The external diameter of a spherical shell is 1 ft. 3 in., and it is ascertained by its weight to consist of  $862\frac{1}{2}$  cub. in. of metal: find its thickness.  $\left(\pi = \frac{22}{7}\right)$
10. Two equal chords, 15 inches in length, are drawn from a point in the circumference of a circle, and contain an angle equal to two-thirds of a right angle; find the area of the circle to 3 places of decimals.

**EXERCISE IX.**

1. Find  $\log_4 64$ ,  $\log_{.001} 100$ ,  $\log_{100} .001$ ,  $\log_{27} 81$ .
2. Find  $\log 5$ ,  $\log 7$ ,  $\log 13$ , having given  
 $\log 35 = 1.544068$ ,  $\log 325 = 2.511883$ ,  $\log 245 = 2.389166$ .
3. Having given  $\log_{10} 3 = .4771213$ ,  $\log_{10} 11 = 1.0413927$ , find  
 $\log_{10} (29.7)^{-\frac{2}{3}}$ ,  $\log_{11} 9$ , and  $\log_3 1210$ .
4. The radius of the inner boundary of a circular ring is 14 in.; the area of the ring is 100 sq. in.; find the radius of the outer boundary.
5. A four-sided field has two sides parallel and the other two sides equal to one another; if the parallel sides are 370 and 250 links long, and each of the equal sides 100 links long, find the acreage.
6. The diameters of two circular pieces of silver are as 2 to 3, and their thickness as 9 to 10; if the smaller piece is worth one shilling, find the value of the larger.
7. The inner and outer diameters of a cylindrical leaden pipe are  $2\frac{1}{8}$  in. and  $2\frac{3}{4}$  in. respectively; if 28 ft. of this pipe be melted down and cast into spherical bullets of diameter .6 in., find how many bullets there will be.
8. How many yards of canvas,  $\frac{1}{2}$  yd. wide, will be required to make a conical tent whose height is 10 ft., and diameter of base is 30 ft. 4 in. ?  $\left(\pi = \frac{22}{7}\right)$ .
9. Compare the diameters of two candles of the same material, one of which is five times as long as the other, if the former burns out in 4 hours, and the other in 5, assuming that equal weights are burnt in equal times.
10. The diagonal of the base of a pyramid on a square base and the diameter of the base of a cone are each 16 ft.; their altitudes are equal, but the volume of the cone exceeds that of the pyramid by 281 cub. ft.: find the altitude of each.  $\left(\pi = \frac{22}{7}\right)$ .

**EXERCISE X.**

1. Find the characteristics of

$$\log_{\frac{1}{\sqrt{3}}} 27, \log_{.01} 3170, \log_{100} (9234 \times 4567).$$

2. Having given

$$\log 12345 = 4.0914911, \log 12346 = 4.0915263,$$

$$\log 64439 = 4.8091488, \log 64440 = 4.8091555,$$

find the tenth root of .0123456.

3. A man borrows £500 from a money-lender; the bill is renewed every half-year with an increase of 12 per cent.: what time will elapse before it reaches £5000? [ $\log 112 = 2.049218$ ].

4. The surface of a cube contains 337 sq ft. 72 sq. in., find its volume.

5. The opposite sides of a quadrilateral are parallel, and the distance between them is 7 chains 50 links; if the area is 6.75 acres, and the length of one of the parallel sides is 10 chains 30 links, find the length of the other.

6. The perimeter of the quadrant of a circle is 14 ft. 7 in., find the radius.  $\left(\pi = \frac{22}{7}\right)$

7. The weights of two spheres are in the ratio of 8 to 17, and the weights of a cubic foot of the substance in each of them are in the ratio of 289 to 64: compare the radii of the two spheres.

8. A pyramid stands on a triangle the length of whose sides are 6 ft. 3 in., 7 ft. 3 in., and 9 ft., and its volume is 10 cubic yards: find its height.

9. The weight of a cylindrical leaden pipe of external diameter 1 in., and length of 1 ft., was found to be half that of a solid cylinder of lead of diameter  $\frac{3}{4}$  in., and length 6 in.: find the internal diameter of the pipe.

10. Given that 30 cub. in. of powder weigh 1 lb., verify the following rule for finding approximately the weight of powder which will fill a spherical shell:

“Multiply the cube of the internal diameter expressed in inches by .01745, and the result will give the number of pounds required.”

**EXERCISE XI.**

1. Having given  $\log 2 = \cdot 3010300$ , find the logarithms of 25,  $\cdot 03125$ , and  $(\cdot 025)^{\frac{1}{2}}$ .

2. Given  $\log 2$  and  $\log 3$ , solve to 3 places of decimals the equations  $2^x 3^y = 1 = 3^x + 12^y - 1$ .

3. Find the value of  $2^{129} 3^{\frac{1}{2}} \div 10^{36}$ , having given  $\log 2$ ,  $\log 3$ ,  $\log 8 \cdot 478 = \cdot 928293$ ,  $\log 8 \cdot 479 = \cdot 928345$ .

4. The external measurements of the sides of a box are 3, 2·2, 1·52 feet; find its volume. Find also the cubical space inside the box (closed by a lid), the thickness of the wood being one-tenth of a foot.

5. Find the circumference (in miles) of a circle whose area is equal to that of a rectangle, the sides of which are 2420 and 1280 yards.

6. The radius of a circular arc is 2 ft. 11 in., and its height is 7 in.; find the length of its chord.

7. The surface of a sphere is 100 sq. in.; find its volume, having given  $\frac{1}{\sqrt{\pi}} = \cdot 56419$ .

8. A circular disc of cardboard one foot in diameter is divided into six equal sectors by six radii; in each sector there is described a circle touching the two bounding radii, and also the arc joining their ends at its middle point: if these circles are cut out, find the area of the cardboard remaining.

9. A right-angled triangle, the length of whose sides are 15 and 20 inches is made to turn round its hypotenuse: find the volume and surface of the double cone so formed.

10. The diameter of a sphere is 6 feet; how many cubic feet of it must be removed that the remainder may form the largest cube that can be cut from it?

**EXERCISE XII.**

1. Given  $\log 2$ , and  $\log 2^{x+3} = 1 \cdot 2221818$ , find the value of  $x$ .

2. Find  $\log \cdot 024$ ,  $\log (234)^4$  and  $\log \sqrt[4]{15^{\frac{3}{2}} \times 51^{\frac{1}{2}}}$ ; also find the number whose logarithm is  $3 \cdot 1187804$ ; having given  $\log 2$ ,  $\log 3$ ,  $\log 13$ ,  $\log 17$ ;  $\log 13 \cdot 145 = 1 \cdot 1187606$ ,  $\log 131 \cdot 46 = 2 \cdot 1187936$ .

3. Apply the series

$$\log_{10} n - \log_{10}(n-1) = \frac{\mu}{n} + \frac{\mu}{2n^2} + \frac{\mu}{3n^3} + \frac{\mu}{4n^4} + \dots,$$

to calculate the value of  $\log 17$ ; having given  $\mu = \cdot 43429448$ ,

$$\log 2 = \cdot 3010300, \log 3 = \cdot 4771213, \log 7 = \cdot 8450980.$$

4. If I pay one guinea for a cubical block of marble of which the side is 1 foot, how much ought I to pay for another cubical block of the same kind of marble, the side of the second block being equal in length to the diagonal of the first?

5. The sides of a triangle are 13, 14, 15 feet; find its area, and the lengths of the three perpendiculars from the angles on the opposite sides.

6. The area of a square is 9·8 acres: find in yards the circumference of the circumscribing circle.  $\left(\pi = \frac{22}{7}.\right)$

7. How long will it take to fill a cylindrical cistern 20 ft. in diameter and 30 ft. deep by means of a leaden pipe three-quarters of an inch in diameter, the water flowing in at the rate of 10 feet a second?

8. The height of a cone is 10 feet, and its volume is 128·282 cub. ft.; find the diameter of its base.

9. A rule to find the weight of a solid iron ball is:

“Multiply the cube of the diameter expressed in inches by 9 and divide by 64; the result will give the weight required in pounds”:

Assuming the truth of the above rule, find the weight in ounces of a cubic foot of iron.

10. A floating light-buoy is in the form of a hemisphere and cone of equal base, joined together at their bases; the hemisphere is 8 ft. in diameter, and the cone is 12 ft. high: find the weight of water the buoy would displace if entirely sunk, a cubic foot of water weighing 1000 oz.; also find the weight of paint required to paint the buoy, if on every 5 square yards there are laid 2 lbs of paint. [ $\sqrt{10} = 3\cdot 162$ .]

**EXERCISE XIII.**

1. Given  $\log 14677 = 4.1666373$ ,  $\log 14678 = 4.1666669$ , find the seventh power of 1.467799.

2. Given  $\log 2$  and  $\log 3$ , solve the equations

$$3^{1-x-y} 4^y = 3^x - 3^y 2^{2x-1} = 1.$$

3. Employ the series

$$\log_{10}(n+1) - \log_{10} n = \frac{\mu}{n} - \frac{\mu}{2n^2} + \frac{\mu}{3n^3} - \frac{\mu}{4n^4} + \dots,$$

to calculate  $\log 43$ ; given  $\log 3$ ,  $\log 7$ , and  $\mu = .43429448$ .

4. A cylindrical pipe 14 ft. long contains 396 cubic feet: find its diameter, and the cost of gilding its convex surface at  $9\frac{3}{4}d$ . per square foot.  $\left(\pi = \frac{22}{7}\right)$ .

5. The volume of a right-angled cone is 77616 cubic feet; find its height.  $\left(\pi = \frac{22}{7}\right)$ .

6. Three circles, each 1 foot in radius, touch each other externally; find the area of the curvilinear figure included between them.

7. Plan a field from the following notes, and find its area in acres, roods, and poles

	Yards	
	To B	
	500	
E 120	420	30 F
C 160	120	160 D
	From A	

8. A ball of iron 4 inches in diameter weighs 9 lbs., and a ball of lead 1 inch in diameter weighs  $\frac{3}{4}$  lb.: find the weight of a ball composed of an iron sphere 8 inches in diameter, coated with a layer of lead 7 inches thick.

9. A person standing due south of a lighthouse observes that his shadow, cast by the light at the top, is 24 ft. long. On walking 100 yds. due east, he finds his shadow to be 30 ft.: if the person is 6 ft. high, find the height of the light from the ground.

10. From a point, whose distance from the surface of a sphere is 3 ft. 4 in., a tangent cone is drawn to the sphere: if the radius of the sphere is 5 ft., find the area of the convex surface of the cone.

### EXERCISE XIV.

1. Given  $\log_{10} 3$  and  $\log_{10} 7$ , find  $\log_3 \sqrt{7}$  and  $\log_{\sqrt{7}} 3$  to three places of decimals.

2. Given  $\log 1.3894 = .1428273$ ,  $\log 1.3895 = .1428586$ , find the eighth root of 13'89492.

3. On a map the distance between Huddersfield and London (which is 189 miles) is represented by a length of 27 inches; if the area of Yorkshire is 3763200 acres, by how many square inches will it be represented on the map?

4. The Great Pyramid of Egypt stands on a square base each side of which is 764 feet, and its height is 480 feet: find its volume in cubic feet.

5. If 30 cubic in. of gunpowder weigh 1 lb., find the weight of powder in a cylinder  $2\frac{1}{2}$  feet long having an internal diameter of 8 inches.

6. Find the number of cubic feet in a rectangular building with an open roof, the height of the side walls being 12 ft., and of the gables 19 ft., and the area of the floor being 76 sq. yds.

7. A sphere, whose diameter is 1 ft., is cut out of a cubic foot of lead, and the remainder is melted down into the form of another sphere: find its diameter.

8. Two cubical blocks of stone contain together 1791153 cubic inches, and the side of the less is to that of the greater as 3 to 4: find the side of each.

9. What length of canvas, which is 1 yard wide, will be required to make a conical tent 20 feet in perpendicular height, and covering 1386 square feet of ground?  $\left(\pi = \frac{22}{7}\right)$

10. A spherical shell of iron, whose diameter is 1 ft., is filled with lead; find the thickness of the iron, when the weights of iron and lead are equal; having given that a cubic inch of iron and lead weigh 4.2 and 6.6 oz. respectively.

**EXERCISE XV.**

1. Given

$\log 2 = \cdot 3010300$ ,  $\log 97656 = 4\cdot 9896989$ ,  $\log 97657 = 4\cdot 9897034$ ,  
find  $\log 244\cdot 14$ , and the eleventh root of  $2 \div \cdot 0009765625$ .

2. Given

$\log 4\cdot 2 = \cdot 6232493$ ,  $\log \cdot 012 = \bar{2}\cdot 0791813$ , and  $\log \cdot 0441 = \bar{2}\cdot 6444386$ ,  
find the logarithms of 5, 7, 8 and 9.

3. Water is poured into a tank 24 ft. 9 in. long, 9 ft. 4 in. broad, and 7 ft. 6 in. deep at the rate of 12 gallons a second; find the rate (in inches per minute) at which the water rises in the tank, and the time of filling it. [A gallon = 277·2 cub. in.]

4. The volumes of two similar solids are as 14641 to 19008; if a side of the first solid is 6 ft. 5 in. long, find the length of the corresponding side of the second.

5. Find the weight of a bombshell, the external and internal diameters of which are 10 in. and 8 in. respectively; the weight of a cubic foot of iron being 7210 ounces.  $\left(\pi = \frac{22}{7}\right)$

6. The length of the arc of a sector of a given circle is 16 ft., and the angle of the sector at the centre of the circle is one-sixth of a right angle; find the area of the sector. Also determine the length of the arc subtending the same angle in a circle whose radius is four times that of the given circle.

7. A prism whose height is 2 ft. 3 in. stands on a triangular base; if the lengths of the sides be 3 ft. 4 in., 3 ft. 3 in., and 2 ft. 1 in., find its volume.

8. A right cylinder (open at the top) with an internal diameter of 24 in. weighs 167·5 lbs.; when filled with water it weighs 2131 lbs.; find its height. [A cubic foot of water weighs 1000 oz.]

9. A ball of lead 4 in. in diameter is covered with gold: find the thickness of the gold in order that (1) volumes of gold and lead may be equal; (2) the surface of the gold may be twice that of the lead.

10. Find the weight of water in a tub in the form of a frustum of a cone; the diameters of the two ends being 3 ft. and 2 ft. 6 in., and the height 4 ft.; given that a cubic foot of water weighs 1000 oz.

## EXERCISE XVI.

1. Find the present value of £3000 due 20 years hence, reckoning compound interest at 5 per cent. per annum; given  $\log 2$ ,  $\log 3$ ,  $\log 7$ , and  $\log 11306 = 4.0533090$ , diff. for 1 = 384.

2. Find the logarithms of .78 and .0039; also calculate the value of  $6\sqrt[12]{65}$ , having given  $\log 2$ ,  $\log 3$ ,  $\log 13$ , and  $\log 84962 = 4.9292247$ ,  $\log 84963 = 4.9292298$ .

3. Find the area of a quadrilateral figure in which the sides are 5, 12, 17 and 22 feet respectively, and the angle between the first two is a right angle.

4. Plan a field from the following notes; and find its area in acres:

	Chains	
	-----	
	To B	
to F 12	40	
to E 5	32	
to D 14	24	
	18	to C 36
	From A	

5. A ball of iron 4 in. in diameter weighs 9 lbs., find the weight of a ball of lead 10 in. in diameter: given that the weight of 15 cubic inches of lead is equal to the weight of 22 cubic inches of iron.

6. If gold can be beaten into a foil whose thickness is  $\frac{1}{28}$  inch, find the greatest area which a sovereign  $\frac{1}{8}$  inch diameter and  $\frac{1}{8}$  inch thick can be made to cover.

7. Find the volume of the zone of a sphere, if the radii of the bases are 3 ft. and 5 ft., and the distance between them is 1 ft. 6 in.

8. How many cubic inches of iron are there in a garden-roller which is half-an-inch thick, with an outer circumference of 5.5 ft., and a width of  $3\frac{1}{2}$  ft.?  $\left(\pi = \frac{22}{7}\right)$

9. Two solid globes of iron whose values are proportional to their weights cost £2. 12s. 1d. and £1. 6s. 8d. respectively; if the price of gilding the smaller globe is 6s., find the price of gilding the larger one.

10. A mast is 42 inches in diameter at the bottom, and 21 inches at the top, and contains 377.3 cubic feet of wood: find its height.  $\left(\pi = \frac{22}{7}\right)$

### EXERCISE XVII.

1. Given  $\log 2$ ,  $\log 3$ ,  $\log 7$ , find the value of

$$\log \frac{15.75}{.672} - 2 \log \frac{1.4}{5.67} + \log \frac{35.84}{2.43}.$$

2. Find the cube root of 84, having given  $\log 2$ ,  $\log 3$ ,  $\log 7$ , and  $\log 43796 = 4.6414344$ , diff. for 1 = 99.

3. The circumference of a circle is 1 yard, find its area in square yards to four places of decimals.

4. How many spherical bullets, each half-an-inch in diameter, may be cast from a rectangular block of lead 1 ft. 10 in. long, 1 ft. 2 in. broad, and 5 in. deep?  $\left(\pi = \frac{22}{7}\right)$

5. On opposite sides of a base, 120 yards long, two isosceles triangles are constructed. The altitude of one triangle is double that of the other, and the triangle that has the least altitude is right-angled: find the area of the quadrilateral thus formed and express the result in acres, roods, &c.

6. The prices of varnishing two solid globes of iron are £1. 17s. 4d. and £2. 7s. 3d. respectively; if the heavier globe weighs 2187 lbs., find the weight of the lighter.

7. A bridge is in the form of an arc of a circle; its span is 234 feet, and its height 13 feet; find the radius of the circle.

8. The bottom of a bath is level, the longer sides slope equally inwards, and the other two sides are vertical; if its length is 120 ft., breadth at top 36 ft., depth measured along sloping slides 8 ft. 4 in., and depth measured vertically 8 ft., find how many gallons of water there are in the bath, reckoning  $6\frac{1}{4}$  gallons to a cubic foot.

9. An officer proceeding to India in a troop-ship is allowed 60 cubic ft. of luggage. A lieutenant had two cases and a basket, one case being 4 ft.  $2\frac{1}{2}$  in. long, 2 ft.  $2\frac{3}{4}$  in. wide, and 2 ft.  $4\frac{1}{2}$  in. deep, and the other being half those dimensions, and the cylindrical basket being  $3\frac{1}{2}$  ft. high by 2 ft. in diameter. By how much did he exceed or fall short of his allowance, actual contents being taken for the cylinder, and fractions of a cubic foot being omitted in the result?

10. A cylindrical tower 24 ft. in diameter, and 30 ft. high, is capped with a hemispherical dome. The top of the dome is cut off, and over the orifice formed is built a cylindrical lantern 8 ft. in diameter, and 10 ft. high, closed at the top by a plane surface: find the total exterior surface of the building.  $\left(\pi = \frac{22}{7}\right)$

### EXERCISE XVIII.

1. Given  $\log 7 = \cdot 8450980$ ,  $\log 12546 = 4\cdot 0985053$ , diff. for 1 = 345, find the product of

$$\sqrt[12]{7}, \sqrt[3]{2401}, \sqrt[5]{49}, (.343)^{-4}.$$

2. Given  $\log 2$ ,  $\log 3$ ,  $\log 7$ ,  $\log 11$ , find

$$\log 27\cdot 5 - \log 4\cdot 48 + 2 \log \cdot 81 + \log 102\cdot 9 - \log \cdot 2673 - 2 \log 35.$$

3. The sides of the base of a triangular prism are 17, 25, and 28 feet, and its height is 20 ft.: find its volume.

4. The difference between the areas of two squares inscribed and circumscribed about a circle is 338 sq. ft.: find the radius of the circle.

5. The area of a lake is 156 acres, and its area on a map is 3·9 sq. in.: find the scale on which the map is drawn, measured in inches per mile.

6. What is the weight of a cylinder formed of sheet-iron  $\frac{1}{2}$  in. thick, with an outer circumference of 10 ft.  $7\frac{1}{2}$  in., and a width of 3 ft. 6 in.? Given that 240 cub. in. of iron weigh 1000 oz., and  $\pi = \frac{22}{7}$ .

7. Determine the number of square yards of material necessary to make a spherical balloon containing 1000 cubic feet of gas.

8. Find the volume of a frustum of a square pyramid, each side of one of its ends being 6 ft., each side of the other end 4 ft., and the perpendicular height 5 ft.

9. A solid sphere of metal whose diameter is two feet is formed into a cylindrical tube whose internal diameter is 14 inches, and length 4 inches: find the thickness of the tube.

10. A solid, consisting of a right cone standing on a hemisphere, is placed in a right cylinder full of water, and touches the bottom. Find the volume of water displaced, having given that the radius of the cylinder is 3 ft., and its height 4 ft., the radius of the hemisphere 2 ft., and the height of the cone 4 ft.

**EXERCISE XIX.**

1. Find the value of  $\sqrt[5]{6300 \times .00117 \times 42.9 \div \frac{1}{2} \sqrt[3]{2197}}$ ,

given the values of  $\log 2$ ,  $\log 3$ ,  $\log 13$ , and  $\log 217.47 = 2.3373994$ , diff. 200.

2. Shew without the use of logarithmic tables that

$$\frac{\log \sqrt{27} + \log 8 - \log \sqrt{1000}}{\log 1.2} = 1 \frac{1}{2}.$$

3. Find the value of

$$7 \log_2 \frac{16}{15} - 5 \log_2 \frac{24}{25} + 3 \log_2 \frac{81}{80}.$$

4. The sides of a rectangle are 308 and 204 inches: how many circles 1 inch in diameter must be taken in order that their area may be equal to that of the rectangle?

5. If a sphere of metal  $8\frac{3}{4}$  inches in diameter weighs 27 lbs., find the weight of a sphere whose diameter is  $11\frac{3}{8}$  inches made of the same metal.

6. A microscope has a magnifying power of 400 diameters; if the perimeter and area of an object under the microscope appear to be 8 in. and 12 sq. in. respectively, find its real perimeter and area.

7. The weight of two solid spheres, made of the same material, are 1024 and 1458 lbs. respectively: if the radius of the first sphere is 2 ft. 8 in., what will it cost to gild the second at 1s. 9d. per sq. ft.?  $\left(\pi = \frac{22}{7}\right)$

8. Cleopatra's Needle consists approximately of a frustum of a pyramid surmounted by a smaller pyramid. If the lower base was  $7\frac{1}{2}$  ft. square, and the upper one  $4\frac{1}{2}$  ft. square, the height of the frustum 61 ft., and of the upper pyramid  $7\frac{1}{2}$  ft., find the cubical contents of the Needle, and its weight; given that 1 cubic foot weighs 170 lbs.

9. A well 6 ft. in diameter and 28 ft. deep is to have a lining of bricks, fitting close together without mortar, 9 in. thick: find in tons the weight of the bricks, supposing a brick  $9 \times 4\frac{1}{2} \times 3$  inches to weigh 5 lbs.  $\left(\pi = \frac{22}{7}\right)$

10. A hollow right prism stands upon a base which is an equilateral triangle; the vertical faces of the prisms are squares, each side of which is 1 foot. The prism is filled with water, and the largest possible sphere is then submerged in it: find the amount of water remaining in the prism, correct to the nearest tenth of a cubic inch.

**EXERCISE XX.**

1. From the equation  $105^x = 100$ , find the value of  $x$  to four places of decimals; given  $\log 2$ ,  $\log 3$ ,  $\log 7$ .

Given  $\log 2$ , and  $\log 2000 \cdot 1 = 3 \cdot 3010517$  find the difference for 1, and the value of  $\log 2000088$ .

2. Employ the series

$$\log(n+1) - \log n = \frac{\mu}{n} - \frac{\mu}{2n^2} + \frac{\mu}{3n^3} - \frac{\mu}{4n^4} + \dots,$$

and 
$$\log n - \log(n-1) = \frac{\mu}{n} + \frac{\mu}{2n^2} + \frac{\mu}{3n^3} + \frac{\mu}{4n^4} + \dots,$$

to calculate  $\log 37$  and  $\log 53$ , having given

$$\mu = \cdot 43429448; \log 3 = \cdot 4771213, \log 17 = 1 \cdot 2304489.$$

3. The weight of an iron ball, whose diameter is 4 in., is 9 lbs.; find the weight of an iron shell whose external and internal diameter are 8 and 5 inches respectively.

4. Find the area of each of the faces of a hexagonal pyramid, each side of the base being 6 ft., and the perpendicular height of the pyramid being 8 ft.

5. The vertical ends of a hollow trough are parallel equilateral triangles, the bases of which are horizontal: if the length of each side is 1 foot, and the distance between the vertical ends is 6 ft., find (1) the number of cubic feet of water the trough will contain; (2) the number of gallons it will contain, given that a gallon of water weighs 10 lbs., and a cubic foot of water 62.5 lbs.

6. A basin is in the form of a segment of a sphere: if the diameter of the top is  $5\frac{1}{2}$  inches, and the depth 1.6 inches, find the number of cubic inches it contains.

7. Find the number of cubic feet in a hexagonal room, each side of which is 20 ft. in length, and the walls 30 ft. high, and which is finished above with a roof in the form of a hexagonal pyramid 15 ft. high.

8. Three points  $A, B, C$ , on the three edges of a cube which meet in  $O$  are distant 15, 16 and 20 in. respectively from  $O$ . If the piece  $OABC$  is sawn off and placed with  $O$  uppermost on a horizontal table, find the area  $ABC$ , and the height of  $O$  above the table.

9. A hemispherical bowl, whose internal radius is one foot, is filled with water, and kept so that the rim is horizontal. A cone whose vertical angle is  $90^\circ$  is placed with its axis vertical, its base at the level of the rim of the bowl, and its apex at the centre of the bottom of the bowl: find the amount of water left in the bowl after the intrusion of the cone.

10. A hollow paper cone whose vertical angle is  $60^\circ$ , is held with its vertex downwards, and in it there is placed a sphere of radius 2 in.; the portion of the cone remote from the apex is then cut away along the line where the paper touches the sphere: find the exterior surface of the body thus formed.

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## EXAMPLES IN THE USE OF LOGARITHMIC TABLES.

In the following series of Examples, the required logarithms must be taken from a book of Logarithmic Tables. In working out the answers Chambers' *Mathematical Tables* have been used, and it will be found that as a rule the results have been given correct to the seventh significant figure; but it should be observed that the seventh figure is not always to be relied on.

Up to Exercise XXX. the numerical value of  $\pi$  has been taken equal to 3.1416 in all cases except those in which the more accurate value is specially quoted; in Exercises XXXI. to XXXV. the value 3.1415926 has been taken.

**EXERCISE XXI.**

1. Multiply  $\cdot 20328956$  by  $\cdot 0069520075$  to 9 places of decimals.
2. Divide  $7\cdot 2614837$  by  $12\cdot 93705$  to 7 places of decimals.
3. Find the fifth root of  $\cdot 0378642$ .
4. Find the cube root of the fifth power of  $\cdot 001174985$ .
5. If  $\frac{x}{7\cdot 6298} = \frac{762\cdot 98}{10645\cdot 55}$ , find  $x$ .
6. What principal will amount to £1864 in 7 years at 3 per cent. compound interest?
7. Find the number of square yards in a regular pentagon whose perimeter is 20 feet.
8. Two angles of a triangle are  $47^\circ 18' 39''$  and  $98^\circ 7'$  and the adjacent side is 864 feet: find the greatest side of the triangle.
9. Find correct to one-thousandth of an inch the side of a square equal in area to a triangle of base  $17\cdot 32584$  inches and altitude  $66\cdot 22658$  inches.
10. A sector of a circle contains an angle of  $45^\circ$ , and the area of the sector is 200 square yards; find the radius of the circle.

**EXERCISE XXII.**

1. Multiply  $31\cdot 210573$  by  $\cdot 007244765$ .
2. Divide  $112\cdot 1467$  by  $\cdot 07832549$ .
3. Find a fourth proportional to  $112\cdot 1467$ ,  $\cdot 007244765$ , and  $31\cdot 210573$ .
4. Find the value of  $(98\cdot 35819)^{\frac{5}{7}}$ .
5. Find the quotient when  $\left(\frac{125}{123}\right)^{10}$  is divided by  $(\cdot 0043)^{\frac{2}{3}}$ .
6. Sum the series  $\frac{4}{3} - \left(\frac{4}{3}\right)^2 + \left(\frac{4}{3}\right)^3 - \dots$  to 25 terms.
7. The three sides of a triangle are 508, 401, 299 feet; find the greatest angle.

8. The population of a town each year increases from one cause by  $\frac{3}{16}$ , and decreases from another cause by  $\frac{1}{12}$  of what it is at the beginning of the year. Find at the end of 9 years the population of a town which was originally 73250 persons.

9. A ship sailing due north observes two lighthouses bearing respectively N.E. and N.N.E. After sailing 20 miles the lighthouses are seen to be in a line due East; find the distance in miles between the lighthouses accurately to four places of decimals.

10. Find in square inches the curved surface of a cone whose slant side is 13.7205 inches and the radius of whose base is 4.5009 inches.

### EXERCISE XXIII.

1. Find the value of  $\frac{.018343463}{3275.6184}$ .
2. Solve the equation  $.05198.r = 7.31508 \times 29.60003$ .
3. Find the square root of  $50.28619 \times 24.13481$ .
4. Find a mean proportional between  $\left(\frac{2}{5}\right)^6$  and  $\left(\frac{5}{2}\right)^7$ .
5. Evaluate  $\frac{42 \times \sqrt[4]{(.0016)^7}}{\sqrt[3]{108}}$ .
6. Find the amount of £1 in 37 years at  $4\frac{1}{3}$  per cent. compound interest.
7. One side of a right-angled triangle is 29 feet 8 in., and the adjacent acute angle is  $27^\circ 33' 49''$ ; find the hypotenuse.
8. The diagonals of a rectangle are 638.645 feet in length and include an angle of  $106^\circ 9' 10''$ ; find the area.
9. Find the perimeter of a regular decagon whose area is 1000 square feet.
10. Find the volume of a right cone whose slant edge is 37.2105 feet, and the radius of whose base is 13.07569 feet.

**EXERCISE XXIV.**

1. Divide 2·8940661 by ·12862516.
2. Find the value of  $\frac{·0372156 \times 62·1943}{·1488624}$ .
3. Solve the equation  $\left(\frac{6}{11}\right)^x = \left(\frac{3}{4}\right)^2$ .
4. Simplify  $\sqrt[5]{\frac{(5·42580)^2}{(·8300204)^3}}$ .
5. Find a mean proportional between the cube of the fifth root of ·8241856 and the square of the seventh root of ·016988.
6. If a farthing is put out at compound interest for 1000 years at 5 per cent., how many digits will be required to express the amount in pounds?
7. The sides of a triangle are 848, 900, 988 links; find the area of the triangle in acres.
8. A sector of a circle whose radius is 100 feet has an angle of  $125^\circ 15'$ ; find the arc of the sector and its area.
9. Find the angle subtended by a sphere of radius 186·675 feet, the observer's eye being placed 3270 feet from the centre of the sphere.
10. It costs £72. 9s. 6d. to gild the surface of a conical spire; the radius of the base is 5·75 feet and the slant side is  $24\frac{2}{3}$  feet: find the cost of gilding a square foot.

**EXERCISE XXV.**

1. Find a mean proportional between ·00046 and 15238860.
2. Evaluate  $(1·00705)^{\frac{3}{5}} \div (23·7259)^{-\frac{2}{3}}$ .
3. Find the harmonic mean between 3·681725 and ·501197.
4. Find the square root of  $\frac{\sqrt[3]{·0125} \times \sqrt{31·15}}{·00081}$ .
5. Find the amount of £680. 10s. in 20 years at  $3\frac{1}{2}$  per cent. compound interest payable half-yearly.

6. How many terms of the series  $\frac{7}{5} + \left(\frac{7}{5}\right)^2 + \left(\frac{7}{5}\right)^3 + \dots$  must be taken so as to give a sum as nearly as possible equal to 180?
7. Find the volume of a sphere whose surface is 25 square inches.
8. The vertical angle of an isosceles triangle is  $50^\circ 18' 54''$ , and the area of the triangle is 10 square feet: find the base.
9. Given  $a = 175.08$ ,  $b = 118.14$ ,  $B = 38^\circ 40'$ , find the remaining parts of the triangle.
10. Find the radius of a sphere whose volume is  $\frac{15}{17}$  of that of a right cone whose base is 12.78015 square inches, and whose height is 3.140082 inches. (Take  $\pi = 3.1415926$ .)

### EXERCISE XXVI.

1. Find a fourth proportional to 3.50185, .00893721 and 17.50925.
2. Divide  $\sqrt[6]{(.1306875)^{1\frac{1}{2}}}$  by  $\sqrt[7]{(14.890005)^{\frac{1}{2}}}$ .
3. Find the value of  $\frac{2.1265 \times .00126 \times 1.00263}{.012834 \times .71 \times 2.61814}$ .
4. Find the geometric mean between the fifth root of the cube of .8241856 and the square of the seventh root of .016988.
5. The present value of £1500 due 12 years hence is £884. 7s. 6d. at compound interest: find the rate per cent.
6. In a right-angled triangle  $a = 5618.97$  and  $A = 61^\circ 40' 35''$ ; find the hypotenuse.
7. In a triangle  $a = 35.2015$ ,  $b = 71.0009$ ,  $A = 15^\circ 32' 48''$ ; find  $B$ .
8. A man who is walking on a level plain towards a tower observes at a certain point that the elevation of the top of the tower is  $10^\circ$ ; after going 50 yards nearer to the tower he finds the elevation is  $15^\circ$ ; determine the height of the tower in yards to four places of decimals.
9. Find the radius of the base of a right cone whose height is 69.6687 feet, given that the volume of the cone is  $\frac{5}{28}$  of the volume of a sphere whose radius is 16.005804 feet.

10. To determine the height of the top  $C$  of a mountain a base  $AB$  of 2700 feet was measured in the horizontal plane; the angle subtended by  $CB$  at  $A$  was  $50^\circ 20' 15''$ , the angle subtended by  $AC$  at  $B$  was  $110^\circ 12' 30''$ , and the angle of elevation of  $C$  from  $B$  was  $10^\circ 7' 45''$ . Find the height of the mountain.

### EXERCISE XXVII.

1. Find the seventh root of the cube of 22·4960085.

2. Determine the geometric mean between  $\sqrt[5]{47\cdot8683}$  and  $(\cdot880359)^4$ .

3. Find the sum of six terms of the series

$$\sqrt[3]{19} + \sqrt[3]{19^2} + \sqrt[3]{19^3} + \dots$$

4. Find the rate per cent. at which £1320 will accumulate to £1778. 8s. in 6 years at compound interest payable quarterly.

5. Find the area of a triangle whose sides are 16·1, 23·45, 29·53 yards respectively.

6. Determine the radius of a sphere whose volume is  $5\frac{2}{3}$  of the volume of a cube whose edge is 43·25 inches.

7. The equation  $x^3 - 8x^2 + 4x + 16 = 0$ , has a positive integral root less than 10, find all the roots correct to 6 places of decimals.

8. Find to six digits the radius of a circle whose area is five-elevenths of the area of a square whose side is 7·3215908 inches.

9. A right circular cone has its height equal to the diameter of its base, and its slant surface is equal to the surface of a sphere; find as a decimal the ratio of the height of the cone to the radius of the sphere.

10. A cylindrical column stands 50 feet high, and its volume is 709·3142 cubic feet; find (1) the diameter of its base, (2) its entire surface.

### EXERCISE XXVIII.

1. Find a third proportional to ·72159 and ·0372005 correct to 8 places of decimals.

2. Divide the square root of the cube of 4·808705 by the fourth root of the fifth power of ·122800598.

3. Find the number of feet in the altitude of a parallelogram whose base is 7·31509 feet and whose area is 1639·855 square inches.

4. Find the amount of £1420. 10s. in 14 years at 5 per cent. compound interest payable quarterly.

5. Find the area of the base of a prism whose altitude is 14·12875 inches, and whose volume is 2764·9378 cubic inches.

6. Determine the radius of a circle circumscribing a triangle whose sides are 175, 261, 400 inches.

7. An obstacle prevents the distance between two towers from being observed, but their distances from a point at which the line joining them subtends an angle of  $35^{\circ} 23' 50''$  are 1358 yards and 2276 yards: find the distance between them.

8. Find the height in feet of a cylinder which has a circular base whose radius is 89·305 inches, and whose volume is equal to 9 times the volume of a sphere whose radius is 12 feet.

9. The curved surface of a cylinder is equal to  $\cdot 39$  of the surface of a sphere whose radius is 152·705 inches. If the height of the cylinder be 29·42 inches, find the radius of the base.

10. The axis of a hollow cone is 2·310616 feet; find the radius of the base so that it shall contain 8·48232 gallons, given that 1 gallon contains 277·274 cubic inches.

### EXERCISE XXIX.

1. Find the value of  $97\cdot9418 \times \cdot 0063864$ , and the seventh root of  $\frac{13}{300}$ .

2. Find the sixth power of the seventh root of the geometric mean between 14·12875 and  $\cdot 40008009$ .

3. Find the present value of £1362. 1s. 8d. due in 20 years at  $3\frac{1}{2}$  per cent. compound interest payable half-yearly.

4. In a triangle  $a=87\cdot50205$  inches,  $b=104\cdot9$  inches, and  $C=122^{\circ} 15' 48''$ ; find its area in square feet.

5. A lighthouse was seen to subtend an angle of  $6^{\circ} 20' 24\cdot7''$  to a man in a boat 300 yards from its base: find the height of the lighthouse.

6. In the triangle which has  $a = 3946$ ,  $b = 6984$ ,  $A = 34^\circ 19' 56''$ . calculate the difference between the two values of  $C$ .

7. A sphere and a cube have the same volume; shew that the surface of the cube is nearly 1.2407 times that of the sphere.

8. An observer standing on a horizontal plane observes the angle of elevation of the top of a mountain to be  $63^\circ 25' 18''$ ; after walking 1 mile towards the mountain on an ascent of  $30^\circ$ , he finds the elevation to be  $74^\circ 25'$ . Find the height of the mountain above the horizontal plane.

9. A cylindrical column stands 50 feet high, and the diameter of its base is 4.25 feet. Find

- (1) the entire surface in square yards,
- (2) the solid content in cubic yards.

10. Find to 4 places of decimals the number of feet in the radius of a sphere whose volume is  $\frac{5}{17}$  of that of a pyramid of height 153.215 inches and base 34.51809 sq. feet.

[N. B. in Examples 9 and 10 take  $\pi = 3.1415926$ .]

### EXERCISE XXX.

1. Find a third proportional to the cube roots of 5.141587 and .007211583.

2. Find the value of  $\frac{(7.014537)^3 - 1}{(7.014537)^3 + 1}$ .

3. Find the present value of an annuity of £300. 7s. 6d. to continue for 25 years at  $4\frac{3}{4}$  per cent. compound interest.

4. The three sides of a triangle are 508, 401, 299 feet; find the greatest angle to tenths of a second.

5. At a certain point on the ground the angle of elevation of the top of a tower is  $50^\circ 15'$ , and that of the sill of a window is  $20^\circ$ ; if the sill is 20 feet from the ground, shew that the height of the tower is nearly 22 yards.

6. The area of a parallelogram is 19.32 square feet, and two adjacent sides contain an angle of  $37^\circ 15' 45''$ ; if one of the sides is 32.7025 inches, find the other side.

7.  $A$  and  $B$  are two stations one mile apart,  $A$  being due north of  $B$ . At the same instant a balloon is seen from  $A$  to bear  $60^\circ 15'$  W. of S., and is seen from  $B$  to bear  $54^\circ 30'$  W. of N.: also the elevation of the balloon as seen from  $A$  at the same time was  $35^\circ 25' 25''$ . Find the perpendicular height of the balloon above the horizontal plane through  $A$  and  $B$ .

8. Two straight roads intersect at an angle of  $30^\circ$ ; from the point of junction two pedestrians  $A$  and  $B$  start at the same time,  $A$  walking along one of the roads at the rate of 5 miles an hour,  $B$  walking uniformly along the other road. At the end of 3 hours  $A$  and  $B$  are 9 miles apart: shew that there are two rates at which  $B$  may walk to fulfil the condition, and determine the slower rate of the two, correct to 4 places of decimals.

9. How many cubic feet are contained in a ditch in the form of a frustum of a wedge 119.75 yards long, 6.03565 feet deep, 10 yards broad at the top, and 4 yards at the bottom?

10. Standing on the paddle-box of a vessel, steaming 14 miles an hour, I see an object in a line with the bow; half an hour afterwards I see it in a line with the funnel. Find the distance of the object from each point of observation, given that the spot on which I stand is 90 feet from the funnel and 150 feet from the bow, and that the funnel and bow are 190 feet apart.

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[In Exercises XXXI. to XXXV. the value of  $\pi$  has always been taken equal to 3.1415926.]

### EXERCISE XXXI.

1. Find the product of 2.371345, 3.845687, 493.4323, and the quotient of 84336 divided by 41731.94.

2. Find a mean proportional between  
 $\sqrt[3]{347.25}$  and  $\sqrt[5]{256.381}$ .

3. Find the present value of £5000 due 12 years hence at  $4\frac{1}{2}$  per cent. compound interest payable half-yearly.

4. How many terms of the series

$$1 + \left(\frac{3}{2}\right)^2 + \left(\frac{3}{2}\right)^4 + \left(\frac{3}{2}\right)^6 + \dots$$

must be taken so as to be as nearly as possible equal to 500?

5. The hypotenuse of a right-angled triangle is 573.1267 in. and one side is 234.9834 inches, find the other side, and the area of the triangle.

6. In a triangle  $a=40$ ,  $b=51$ ,  $c=43$ , find  $A$ , and the area.

7. Find the height of a right circular cylinder the radius of whose base is 26.85 inches and whose volume is 127 cubic feet.

8.  $AB$  is a horizontal line whose length is 400 yards; from a point in the line between  $A$  and  $B$  a balloon ascends vertically, and after a certain time its altitude is taken simultaneously from  $A$  and  $B$ ; at  $A$  it is observed to be  $64^{\circ} 15'$  and at  $B$   $48^{\circ} 20'$ ; find the height of the balloon when the observations are taken.

9. Find the area of a regular decagon circumscribed to a circle whose radius is 53.8479 inches.

10. Find the cost of canvas for a conical tent whose base is a circle of radius 5.83 feet and whose vertical height is 16.97 feet, at 1s. 2d. a square yard.

### EXERCISE XXXII.

1. Find a third proportional to

$$\sqrt[3]{573.21} \text{ and } \sqrt[4]{379.475}.$$

2. If the number of persons born in any year be  $\frac{1}{25}$  of the whole population at the beginning of the year, and the number of those who die  $\frac{1}{30}$  of it, find in how many years the population will be doubled.

3. Find the quotient when the 5<sup>th</sup> power of 24.13781 is divided by the continued product of 3.78, 42.356,  $\sqrt[3]{328.7}$ .

4. Find correct to a farthing, the present value of £10000 due 8 years hence at 5 per cent. per annum.

5. Determine the edge of a cube whose volume is  $7\frac{3}{4}$  of the volume of a sphere whose radius is 18.316 inches.

6. The area of a parallelogram is 27.356 sq. feet and two adjacent sides contain an angle  $42^{\circ} 15' 7''$ ; if one of the sides is 49.568 inches, find the other side.

7. A man who is walking on a level plain towards a tower observes at a certain point that the elevation of the top of the tower is  $10^{\circ}$ , and after going 50 yards nearer to the tower, that the elevation is  $15^{\circ}$ . Find the height of the tower in yards to four places of decimals.

8. Calculate approximately the area and circumference of a circle inscribed in a square whose side is 359.5678 feet.

9. Find the volume of a prism on a triangular base the sides of which are 47.3, 38.9, 2.7 inches respectively, the height being 55.8 inches.

10. If  $V$  is the volume of a sphere and  $A$  the area of its surface, prove that

$$3 \log A = 2 \log V + \log \pi + 2 \log V.$$

Calculate the value of  $A$ , if  $V = 796.325$  cubic inches.

### EXERCISE XXXIII.

1. Evaluate (1)  $52.4574 \times 3.78472$  ;  
 (2)  $(5.7432)^{1.246}$ .

2. Find to six places of decimals the value of  

$$\frac{87.327 \times 784.55 \times .020868}{.61659 \times 58.844}$$

3. How many terms of the series  
 $.04, .08, .16, .32, .64, \dots$

will amount to 41943 ?

4. A person borrowed £11000 for two months at 5 per cent. per annum. At the end of the time he was unable to pay the interest ; it was, therefore, added to the principal and the debt was allowed to run for another two months. This was continually repeated, till at the end of 2 years the debt and interest were paid ; how much did this amount to ?

5. Looking due South from the top of a cliff which is 37.7 yards high, an observer sees two objects whose angles of depression are  $27^\circ 18' 35''$  and  $43^\circ 12' 14''$  respectively ; find the distance between them.

6. A ship sailing due East is observed at 10 o'clock to be in a direction  $15^\circ 37'$  East of South ; at 12.15 the ship is observed to be  $57^\circ 12'$  East of South ; if the ship sails 10 miles an hour, find the distance of the observer from each position of the ship.

7. Compute to the nearest square inch the area of a circle in which a chord 4 ft. in length subtends at the centre an angle  $28^\circ 36'$ .

8. The diagonal of a cube is 58.9342 inches ; find the radius of a sphere whose surface is equal to that of the cube.

9. In a triangle  $a=13.72$ ,  $b=15.68$ ,  $c=10.36$ , find its area, and the radii of the circum-circle and in-circle, to 4 places of decimals.

10. In the triangle of example 9, find the radii of the escribed circles, and verify the formula

$$r_1 + r_2 + r_3 - r = 4R.$$

### EXERCISE XXXIV.

1. Find a mean proportional to

$$(15.37859)^{\frac{2}{7}} \text{ and } (24.25683)^{\frac{3}{14}}.$$

2. Find to seven places of decimals the value of  $x$  which satisfies the equation

$$\frac{x+2}{x-2} = 337.231.$$

3. How long must a ladder be so that if it is placed against a vertical wall making an angle of  $65^\circ 17'$  with the ground its foot may be 10.7 feet from the wall?

4. From two consecutive milestones on a straight road observations are taken of the altitude of a hill towards which the observer is walking. Given that the angles of elevation are  $18^\circ 15' 12''$  and  $65^\circ 42'$ , find the height of the hill.

5. Given  $a=5$  inches,  $b=7$  inches,  $A=31^\circ 15'$ , find the area of the larger of the two triangles which satisfy these data.

6. Find the volume of a right circular cone the height of which is 14.877 feet, and the circumference of whose base is 13.6 feet.

7. Find the cost of boarding over a circular piece of water whose radius is 54.3678 feet at  $3d.$  a square foot, allowing for a circular basin in the middle with a radius 3.89243 feet.

8. A rectangular cistern has the following dimensions: height 12.56 ft., length 22.94 ft., breadth 14.754 ft.; find the price of ground, at  $4s. 2d.$  a sq. yard, on which to erect a cylindrical cistern of the same volume and height.

9. Given that a cubic foot of water weighs 1000 ounces, find what weight of water will be contained in a trough 11.431 feet long whose ends are isosceles triangles having a vertical angle  $73^\circ 23' 15''$  and equal sides 2.315 feet long.

10. How many cubic feet of air are contained in a tent in the form of a circular cylinder surmounted by a cone, the radius of the base being 117·8 inches, the vertical sides 124·3 inches, and the extreme height to the vertex of the cone 217·9 inches?

### EXERCISE XXXV.

1. Find a fourth proportional to

$$\sqrt[3]{32\cdot7812}, \sqrt[5]{357\cdot814}, \sqrt[4]{7836\cdot43}.$$

2. Evaluate

$$\frac{\sqrt[5]{(375\cdot842)^3}}{987\cdot35 \times 31\cdot8973}.$$

3. Find to four places of decimals the value of the product of  $(47\cdot321)^{1\cdot39}$  and  $(3\cdot8956)^{1\cdot24}$ .

4. Find to two places of decimals the area in square inches of a regular figure of 17 sides circumscribed about a circle whose radius is 5·738 inches.

5. Find the radius of the base of a circular cylinder whose height is the same as that of a cone of equal volume on a circular base whose area is 25 square feet.

6. Find the volume of a right circular cone whose height is 57·3568 feet and whose vertical angle subtended by a diameter of the base is  $54^\circ 16' 20''$ .

7. If there are 277·274 cubic inches in a gallon of water, how many pints will be contained in a glass in the form of a frustum of a cone, the height being 4 inches, and the diameters at the top and bottom being  $3\frac{1}{4}$  and  $2\frac{1}{2}$  inches respectively?

8. A battery is 6000 yards from a fort, and each of two ironclads of a blockading squadron is 4800 yards from the fort. It is found that when a gun in the battery is sighted on the fort it has to be turned through an angle of  $40^\circ 17' 50''$  in order to point towards the nearest ironclad, and that the two ironclads are then in the same straight line; find their distances from the battery.

9. Find the volume of a boiler whose shape is that of a cylinder 5·732 feet long, with hemispherical ends, 3·1576 feet in diameter. Find also the cost of painting the boiler at 3*s.* a square foot.

10. From a sphere of copper of radius 4·769 inches, 5·9217 lbs. of wire ·178 inches in diameter are made; and from the remaining copper a solid cylinder 99·7824 inches long is constructed. Find how many times the wire can be wound round the cylinder, having given that one cubic foot of copper weighs 555 lbs.

**XL. PAGE 28.**

1.  $\cdot 0\dot{5}$ ;  $\cdot 00\dot{7}$ ;  $\cdot 00001\dot{6}$ ;  $\cdot 05752\dot{8}$ .      2. 12 weeks.  
 3. 63 cwt.      4.  $7\frac{7}{9}$ , or 70 : 9.      5. £1. 11s. 11d.  
 6. A man, £1; a woman, 15s.; a boy, 10s.; a girl, 9s.  
 7.  $1135\frac{5}{12}$  yards.      8. 4 men do as much as 5 boys.

**XLI. PAGE 29.**

1. (1) 503·08. (2)  $49\frac{5}{98}$ .      2. £342787. 10s.  
 3. £2560. 14s. 8 $\frac{1}{4}$ d.      4. £558. 18s. 9d.  
 5.  $\cdot 055$ .      6.  $4\frac{1}{2}$  days.  
 7.  $1348\frac{4}{5}$  ( $= 1458 - 109\frac{1}{5}$ ).      8. £1. 8s. 8 $\frac{3}{4}$ d.

**XLII. PAGE 30.**

1.  $5 (= 2\cdot 3424\dot{3} + 2\cdot 6575\dot{6})$ .      2. 3840.  
 3. £79. 5s. 5 $\frac{1}{4}$ d.      4.  $\cdot 28125$ .      5. 1.  
 6. The rate of the bicyclist is to the rate of the train as 9 to 20.  
 7. £29. 5s.      8. About  $10\frac{1}{2}$  minutes past 7 P.M.

**XLIII. PAGES 30, 31.**

1.  $\frac{130}{177} = \cdot 7344$ .      2.  $3\frac{10}{11}$ .      3. 13s. 2d.  
 4. £76. 1s. 6d.      5. £71. 1s. 5 $\frac{1}{4}$ d.      6. £1345. 19s. 10 $\frac{1}{2}$ d.  
 7. A, £42; B, £56; C, £48.      8. 12 oz.

**XLIV. PAGE 31.**

1. 1.      2. 180 men.      3. £162.  
 4. £150. 11s. 1 $\frac{1}{2}$ d.      5.  $\cdot 0275$ .      6. £653. 5s.  
 7.  $3\cdot 162$ ;  $264\sqrt{10}$  shillings, or £41. 14s. 9d. nearly.  
 8. Speed of bicyclist is to that of man on horseback as 8 to 9.

**XLV. PAGE 32.**

1.  $\frac{13}{32}$ ;  $\frac{19}{48}$ ;  $\frac{1}{96}$ .      2. £4. 5s. 3 $\frac{3}{4}$ d.; 13·23958 $\dot{3}$ .  
 3. 3 $\frac{1}{2}$  years.      4. 2 ft. 2 in.      5.  $\frac{1}{3}$ .  
 6. £937. 13s. 2d.      7. 16·1.      8. 123·2 grains.

**XLVI.** PAGES 32, 33.

- |                            |                           |                 |
|----------------------------|---------------------------|-----------------|
| 1. £559. 12s. 3½ <i>d.</i> | 2. £816. 12s. 6 <i>d.</i> | 3. .00795̄4̄.   |
| 4. 162 yds. 1 ft. 4 in.    | 5. 4½ days.               | 6. 6¼ per cent. |
| 7. £12.                    | 8. 48 miles.              |                 |

**XLVII.** PAGE 33.

- |                                    |                            |                           |                         |
|------------------------------------|----------------------------|---------------------------|-------------------------|
| 1. $\frac{1}{7} = .14285\dot{7}$ . | 2. 3-093681320.            | 3. £9656. 8s. 5 <i>d.</i> | 4. $\frac{1}{36}$ inch. |
| 5. 960 men.                        | 6. £127. 13s. 6½ <i>d.</i> | 7. £96. 6s.               | 8. 44·4 lbs.            |

**XLVIII.** PAGE 34.

- |                          |                  |                                       |
|--------------------------|------------------|---------------------------------------|
| 1. 18.                   | 2. ·401; 2·49.   | 3. £78. 15s.                          |
| 4. £52. 10s.             | 5. 1¼ years.     | 6. $1\frac{3}{8}$ hrs. = 23¼ minutes. |
| 7. £18. 5s. 8½ <i>d.</i> | 8. 176785½ tons. |                                       |

**XLIX.** PAGES 34, 35.

- |   |                      |            |
|---|----------------------|------------|
| 1. 6804; $\frac{25}{1134}$ .  | 2. $\frac{2}{225}$ . | 3. 7½ cwt. |
| 4. 4 per cent.  | 5. 1974; 1512.       | 6. 81 men. |
| 7. In 120 days, i.e. at 2 P.M. on April 24; 1.44 P.M. and 2.14 P.M. |                      |            |
| 8. 2½ years.  |                      |            |

**L.** PAGE 35.

- |                           |                     |                       |
|---------------------------|---------------------|-----------------------|
| 1. ·058704.               | 2. 2·267857142.     | 3. £2350.             |
| 4. £37. 19s. 4½ <i>d.</i> | 5. 10¼ inches.      | 6. £900; £1120; £750. |
| 7. 61256250 tons.         | 8. £31350 increase. |                       |

**LI.** PAGE 36.

- |   |                           |
|---|---------------------------|
| 1. 206·25 yards.  | 2. £1731. 7s. 7 <i>d.</i> |
| 3. A, £35. 15s.; B, £41. 6s. 10 <i>d.</i> ; C, £59. 12s. 7 <i>d.</i>  |                           |
| 4. 50 per cent.   | 5. 0.                     |
| 6. 128 rooms.   | 7. 5 per cent.            |
| 8. 2². 3. 5. 11. 13²; 2⁵. 3³. 7²; 2⁶. 3⁴. 13. Quotients 2⁴. 3³. 7²; 2. 3. 5. 11. 13²; 5. 7². 11. 13. [L.C.M. 2⁶. 3⁴. 5. 7². 11. 13².] |                           |

**LII.** PAGE 37.

- |   |                  |                        |
|---|------------------|------------------------|
| 1. £22.                                 | 2. £446. 10s.    | 3. £9. 3s. 3 <i>d.</i> |
| 4. ·2; ·116.                            | 5. £383.         | 6. 1·52098 pints.      |
| 7. Brussels to Kidderminster as 9 to 8. | 8. £7500; £3750. |                        |

**LIII.** PAGES 37, 38.

- |                              |                          |                                |
|------------------------------|--------------------------|--------------------------------|
| 1. 1.                        | 2. $142\frac{1}{2}$ lbs. | 3. 57·13; 8·0622.              |
| 4. 8·4 hours.                | 5. £10938. 19s. 2d.      | 6. £1. 13s. 0 $\frac{1}{2}$ d. |
| 7. 3 $\frac{1}{2}$ per cent. | 8. 12s. 6d.              |                                |

**LIV.** PAGES 38, 39.

- |                     |                                  |                                |
|---------------------|----------------------------------|--------------------------------|
| 1. ·73625; 6s. 10d. | 2. £467. 11s. 6 $\frac{3}{4}$ d. | 3. £1. 3s. 11 $\frac{1}{2}$ d. |
| 4. 9·928259350.     | 5. $91\frac{1}{4}$ .             | 6. $1\frac{196}{205}$ .        |
| 7. 7s. 6d.          | 8. 30 days.                      |                                |

**LV.** PAGE 39.

- |                          |   |                          |
|--------------------------|---|--------------------------|
| 1. £271. 8s. 7d.         | 2. 1320 yards.                              | 3. $2\frac{29}{30}$ ; 6. |
| 4. 4 inches.             | 5. £2212.                                   | 6. ·71828.               |
| 7. 995 $\frac{5}{8}$ oz. | 8. One part of water to eight parts of gin. |                          |

**LVI.** PAGE 40.

- |   |   |                     |
|---|---|---------------------|
| 1. ·0058892.  | 2. £2771. 12s. 6d.                              | 3. 1029·2034 drams. |
| 4. $6\frac{5}{6}$ .   | 5. 52 $\frac{1}{2}$ per cent. [D's marks 3125.] |                     |
| 6. £12. 12s. gain.  | 7. 24768 tiles.                                 |                     |
| 8. 4 $\frac{1}{8}$ years. [Rate of interest is 4 per cent.] |   |                     |

**LVII.** PAGES 40, 41.

- |                                   |                         |                |
|-----------------------------------|-------------------------|----------------|
| 1. £2418. 17s. 3 $\frac{1}{2}$ d. | 2. 7s. 7d.              | 3. 18 men.     |
| 4. $\frac{4}{5}$ year.            | 5. 1458 yards.          | 6. £1. 2s. 2d. |
| 7. £50350. 12s. 6d.               | 8. £119 $\frac{7}{8}$ . |                |

**LVIII.** PAGES 41, 42.

- |                 |  |  |
|-----------------|--|--|
| 1. £99. 3s. 4d. | 2. ·97765 $\dot{1}$ .                                | 3. £204.                                     |
| 4. 121695.      | 5. 0. $\left[ = \frac{1}{2} - \frac{1}{2} \right]$ . | 6. $113\frac{1}{623} = 113\cdot0016$ grains. |
| 7. 20 per cent. | 8. Sixty; in the sixth decimal place.                |  |

**LIX.** PAGE 42.

1. 65120.      2. £903. 15s.      3. 5·4198 oz.      4.  $6\frac{1}{2}$  gallons.  
 5.  $14\frac{233}{242}$ .      6. £120.      7. £44. 0s. 10d.      8. 2·23608 lbs.

**LX.** PAGES 42, 43.

1. £1. 5s.      2. A, 20 per cent.; B,  $15\frac{1}{8}$  per cent.  
 3.  $7\frac{7}{8}$  months.      4. £3 loss.      5. £6. 17s.  $9\frac{3}{4}$ d.  
 6. £15600.      7. £666. 13s. 4d.      8.  $28\frac{3}{8}$  miles.

**LXI.** PAGES 43, 44.

1. ·04625; £2. 1s.  $5\frac{1}{2}$ d.      2. £4. 7s. 6d.      3.  $92\frac{14}{15}$ .  
 4. £40. 12s.  $8\frac{1}{2}$ d.      5.  $322\frac{3}{8}$  yards.      6. £450.      7.  $\frac{1}{18}$  sq. inch.  
 8. As 155 to 147. [The rates are  $4\frac{16}{21}$  and  $4\frac{16}{31}$  per cent.]

**LXII.** PAGES 44, 45.

1. £190. 18s.  $7\frac{3}{4}$ d.      2. 320 eggs.      3.  $\frac{121}{123}$ ;  $209\frac{1}{2}$  yds.  
 4. £41. 13s. 4d.      5.  $107\cdot77164\dot{7}4935\dot{9}$ ; 1·6875.  
 6. 3 lbs. 7 oz. 15 dwt. [875 Troy dwt. = 48 Av. oz.]  
 7. 2 tons 1 cwt. 2 qrs. 2 lbs.      8. 3000 nuts; 5s. 10d.

**LXIII.** PAGE 45.

1.  $\frac{25}{144}$ .      2. £3. 6s.  $4\frac{1}{2}$ d.; ·298828125.      3. 8 per cent.  
 4. 14479674 gallons.      5. ·264575...; 2750 yards.  
 6. No alteration; the income is £96 in each case.  
 7. £275.      8. £12000.

**LXIV.** PAGE 46.

1. ·0000029; 80000000; 4·05536;  $5\cdot07\dot{9}6\dot{2}$ ;  $\frac{15}{16}$ ;  $\frac{133}{270}$ .  
 2. £702. 13s. 4d.      3. ·18984375; 15s.  $2\frac{1}{2}$ d.  
 4.  $3\frac{1}{8}$  days.      5. 12 feet.      6. £40.  
 7. A, £930; B, £46. 10s.; C, £581. 5s.      8. £90.

**LXV.** PAGE 47

1. 3016.      2. £588. 12s.      3. (1) 66. (2) 18.  
 4. 2 yds. 1 ft.  $2\frac{5}{8}$  in.; ·009521484375.      5. £77 $\frac{1}{2}$ .  
 6. 223·358 gallons; 20·057 oz.      7.  $34\frac{1}{8}$  miles.      8. £75.

**LXVI.** PAGE 48.

1.  $6\frac{3}{8}$  per cent.      2. 233 sq. ft. 46 sq. in.      3.  $2\frac{2}{3}$  years.  
 4. 8 per cent.; cost price £156. 5s.      5. 141·2.  
 6. 8000000 gallons.      7. Length 24 ft.; breadth 18 ft.; height 12 ft.  
 8. £2015.

**LXVII.** PAGE 49.

1. 742 cub. ft.      2. 3 per cent. [The time is  $6\frac{3}{8}$  yrs.]  
 3. £5. 3s. 6d.      4. 10s.  $11\frac{1}{4}$ d.      5.  $3\frac{1}{2}$  days.  
 6. 1·0349; 543.      7. £4. 1s.      8. £3104.

**LXVIII.** PAGES 49, 50.

1. 11·0112 pints.      2. £307. 3s.  $4\frac{1}{2}$ d.  
 3. 2·3·5·7·11;  $2^3·3^2·7·13$ ;  $2·3^5·5^2$ .  
     L.C.M. =  $2^3·3^5·5^2·7·11·13 = 48648600$ .  
 4. 1.      5. 30000 metres.  
 6. Yes; side of cube = 15·9 ft.; side of square = 194·4 in.  
 7. The second by £10; incomes £146. 5s. and £156. 5s.  
 8. £625; the interest is 4 per cent.

**LXIX.** PAGE 50.

1.  $266\frac{6}{7}$ ;  $1\frac{5}{7}$ .      2.  $7\frac{1}{2}$ ; 8.      3.  $2181\frac{3}{8}$  cub. in.      4.  $50\frac{3}{4}$ d.  
 5. £56250.      6. 1534 cub. ft.  $1196\frac{1}{8}$  cub. in.      7.  $51^\circ$ .  
 8. £6. 3s. [Amount to invest is £1765. 19s., and the incomes are £57. 18s. and £64. 1s.]

**LXX.** PAGE 51.

1.  $4\frac{5}{7}$ ; ·0006;  $2\frac{7}{8}$ .      2. 13s. 6d.      3. £4. 9s.  $5\frac{3}{8}$ d.  
 4. 86 yards.      5. 340·8 galls.      6.  $2\frac{11}{32}$ , or 2·34375 per cent.  
 7. £22. 2s. 6d. gain. [Incomes £88. 10s. and £110. 12s. 6d.]  
 8. 176 yards.

**LXXI.** PAGES 51, 52.

1.  $\cdot 741\bar{6}$ ; 1 min. 29 sec.
2. 68 yds.; £1. 5s. 6d.
3. £793. 19s. 6d.
4. *A*, 470. 8s.; *B*, £460. 15s.
5.  $9\frac{3}{4}$  weeks; £341. 5s.
6. 2825761; 2560000.
7. First, 9s.  $4\frac{1}{2}d.$ ; second, 5s.  $7\frac{1}{2}d.$ ; third, 1s.  $10\frac{1}{2}d.$ ; rates: first,  $2\frac{1}{2}d.$ ; second,  $1\frac{1}{2}d.$ ; third, 1d.
8. £104. 8s.  $9\frac{1}{2}d.$

**LXXII.** PAGES 52, 53.

1. 7 lbs. 3 oz. 12 dwt.
2.  $\frac{22565}{34598}$ .
3. 1 ton 1 cwt. 26 lbs.
4. £58. 18s.  $11\frac{1}{4}d.$  nearly.
5.  $7\frac{1}{7}$  years.
6. £98. 7s. 4d.
8. 19 lbs. of the better tea to 10 lbs. of the inferior.

**LXXIII.** PAGES 53, 54.

1. £184. 0s. 5d.
2.  $\cdot 11157177\dots$
3. Lost 13·5 per cent.
4. 14 minutes.
5.  $759\frac{2}{3}$  sq. ft.
6. £715.
7. *B*'s rate is  $3\frac{2}{3}$  miles; 6 miles an hour.
8.  $640\frac{1}{2}$  yards.

**LXXIV.** PAGES 54, 55.

1.  $\frac{37}{48}$ .
2. £8333. 6s. 8d. [Principal =  $\frac{200}{207} \cdot \frac{200}{207} \cdot \frac{200}{207}$  of amount.]
3. 19 lbs. of the better tea with 26 lbs. of the inferior.
4.  $\cdot 3465736$ .
5.  $18\frac{2}{3}$  per cent.
6. *B* will win by  $4\frac{2}{3}$  ft.
7. Amount of Stock, £14400; price £83 $\frac{1}{4}$ .
8. *A*, 2800; *B*, 2772.

**LXXV.** PAGE 55.

1. 31·0064942;  $\cdot 4342945\dots$
2. 6·6040375466118.
3. £5241. 11s.  $8\frac{1}{2}d.$
4. 32 points.
5. £222. 10s. loss. [Incomes £1230, £1007. 10s.]
6. 2 minutes; 880 yards.
7. 1 ft.  $11\frac{1}{2}$  in.
8. 60, 70, 84, 105 revolutions.

**LXXVI.** PAGE 56.

1. 3125 sheep.
2. 180; £2. 5s. 1d.
3. £50 increase.
4. 32 minutes.
5. £1. 19s.  $4\frac{1}{2}d.$  nearly.
6. 250 times.
7. £4166. 13s. 4d. [Principal =  $\frac{1000}{1051} \cdot \frac{1000}{1051}$  of amount.]
8.  $152\frac{1}{8}$  lbs.

**LXXVII.** PAGES 56, 57.

1.  $189\frac{1}{7}$ .
2. 10 gulden.
3. £3550; £3124; £2982; £14 less; £4 more; £10 more.
4. Gain, 28 per cent.; Loss,  $21\frac{1}{8}$  per cent.
5. 1000 men.
6. £19. 4s. 11d.;  $7\frac{1}{3}$  years nearly.
7. £289 increase.
8. 8 ft.;  $8\sqrt{3}=13\cdot856$  ft.;  $38\frac{1}{4}$  sq. ft.

**LXXVIII.** PAGES 57, 58.

1. (1) 0. (2)  $5\frac{5}{24}$ .
2. 1s.  $3\frac{1}{4}$ d.
3. 5 per cent.
4. 2 inches.
5.  $11\frac{1}{3}$  minutes.
6. In gallons, *A*,  $21\frac{3}{4}$  water,  $2\frac{1}{4}$  wine; *B*,  $2\frac{1}{4}$  water,  $9\frac{3}{4}$  wine.
7. 12 min. past 5.
8. £16800 stock; £96 increase.

**LXXIX.** PAGES 58, 59.

1. 8 hrs.
2. 5.12 P.M. Thursday.
3. £559. 13s. 9d.
4. £4305.
5. 1728000 times.
6. *B* by 4 sec.; *A*, 320 sec., *B* 316 sec.
7. £92.
8. £2. 3s.  $2\frac{1}{2}$ d. gain.

**LXXX.** PAGES 59, 60.

1.  $\frac{1}{4}$  gallon.
2. 10.55 A.M.
3. 200 men.
4.  $11\frac{1}{4}$  sec.
5. 16 : 15.
6. *A*,  $261\frac{3}{7}$  days; *B*, 120 days.
7. 102 Spanish bonds.
8.  $14\frac{7}{8}$  per cent.; in the proportion of 7 parts of the better article to 5 parts of the inferior.

## EXAMINATION PAPERS.

**I.** PAGES 61, 62.

1. £10. 3s.  $7\frac{3}{4}$ d.
2. £48. 11s. 10d.
3. £1806. 13s. 6d.
4.  $\frac{15}{29}$ ;  $\frac{81}{1120}$ .
5. 2s. 8.72d.; 5s.  $5\frac{1}{11}$ d.;  $3\cdot273334\dot{i}$ .
6. 99600400; 950; 1.581.
7. £1000.
8. Interest is £325. 5s. 4d. Difference is £12. 2s.  $3\frac{1}{2}$ d.
9. £653. 2s. 6d.
10.  $12\frac{1}{3}$  francs.

## II. PAGE 62.

1. £4. 9s. 8½*d.*
2. 25 poles 2 yds. 10 in.; 30 ac. 3 r. 16 p. 22 yds. 3 ft. 112 in.
3. £222. 1s. 1¾*d.*    4. £19. 8s. 10¾*d.*    5.  $1\frac{5}{14}$ ;  $450\frac{24}{49}$ ;  $24\frac{79}{150}$ ;  $\frac{7}{192}$ .
6. .125; .00009375; 1.04629. Because 432 contains factors other than 2 and 5.
7. 108266244; 32.135.    8. £4249. 0s. 9*d.*    9. £125. 2s. 6*d.*

## III. PAGE 63.

1. 3731364.    2. £26. 2s. 1¾*d.*    3. £120. 4s. 2½*d.*
4. 208 tons 13 cwt. 2 qrs. 5 lbs.; 144 tons 3 cwt. 2 qrs. 4 lbs.; remainder 13 lbs.
6. 26; 720.    7.  $\frac{275}{903}$ ;  $\frac{35}{52}$ ;  $\frac{2}{7}$ .    8.  $18\frac{3}{4}$ ;  $3\frac{43}{50}$ .
9. £172.    10. First 45, second 90, third 175.

## IV. PAGE 64.

1. 5555657; 3086521; 5334678204552.
2. Two thousand three hundred and six millions, two hundred and thirty-six thousand, eight hundred and fifty-six; £192186404. 13s. 4*d.*;  $40038\frac{3}{8}\frac{3}{8}\frac{3}{8}$  days.
3. £4806. 15s.    4. 1287; 8964648.
5. The original capital is £36713. 5s.; and the increments of capital in the successive years are  $\frac{1}{6}$ ,  $\frac{1}{30}$ ,  $\frac{1}{20}$ ,  $\frac{1}{12}$ ,  $\frac{1}{6}$ , and  $\frac{1}{2}$  of the original capital.
6.  $2\frac{5}{7}$ .    7.  $64\frac{2189}{3000}$ , or 64.7296.    8.  $2\frac{7}{8}$  days.
9. .80000.    10. 1.1832157.    11. £3.

## V. PAGES 65, 66.

1. 360; 216; 20736; 4.    2. £3215. 14s. 3*d.*
3. 25 mi. 6 fur. 6 po. 2 ft. 4 in. 42524 hhd. 57 gals. 3 qts. 1 pt. 2 gills. [A hogshead = 63 gallons, 1 pint = 4 gills.] 146929459 sq. in.
4.  $3\frac{1}{3}$ ;  $\frac{7}{9}$ .    5.  $4\frac{11}{12}$ ; 2.    6. 35 days.
7. £1217. 19s. 4½*d.*    8. £23. 13s. 11½*d.*; 16.
9. £52. 12s. 8¼*d.*; £293. 5s. 2¼*d.*    10. 4280730.

## VI. PAGES 66, 67.

1. 29765890000.    2. The fractions are equal to  $\frac{27}{36}$ ,  $\frac{30}{36}$ ,  $\frac{28}{36}$ ,  $\frac{31}{36}$ ,  $\frac{29}{36}$ .
3.  $\cdot\dot{7}1428\dot{5}$ ;  $\cdot625$ ;  $\cdot\dot{5}$ ;  $\frac{2}{3}$ ;  $\frac{1}{15}$ ;  $\frac{2}{33}$ ;  $\cdot7\dot{9}\dot{3}$ .    4.  $\cdot878125$ ;  $\cdot\dot{3}\dot{6}$ .
5. 275 sq. ft. 72 sq. in.; £6. 17s. 9d.    6. 8 days.
7. Tea 2s. 8d., coffee 1s. 8d., sugar  $3\frac{1}{2}$ d. per lb.
8.  $8\frac{1}{2}$  per cent.; £971. 5s.    9. £1. 15s.
10. In 400 hours; 2'.  $46\frac{3}{4}$ " to 4 A.M., and 2'.  $13\frac{1}{8}$ " after 4 A.M.

## VII. PAGES 67, 68.

1. 1 ton 7 cwt. 3 lbs. 3 oz. 9 drs.    2. 24 times.    3. 153600.
4. *A* 162, *B* 108, *C* 72 runs.    5.  $\cdot02602053$ ;  $128496\cdot\dot{4}$ ;  $\cdot2\dot{7}\dot{0}$ .
6. 1003·003001; 257·16787...    7.  $5\frac{8}{10}$  per cent.; 5 per cent.
8. £766. 13s. 4d.    9. £1. 1s.
10. Height  $12\frac{1}{2}$  ft. [Length 45 ft., breadth 15 ft.]

## VIII. PAGES 68, 69.

1. 72; £3. 13s. 6d.
2. £96424. 10s.  $10\frac{3}{4}$ d. Ninety-six thousand four hundred and twenty-four pounds, ten shillings and ten pence three farthings.
3.  $353\frac{3}{8}$  yds.    4.  $2\frac{8}{17}$ ;  $\frac{8}{17}$ ;  $24\frac{7}{10}\frac{9}{10}$  miles.
5. 5·8;  $\cdot0058$ ;  $\cdot61458\dot{3}$ ;  $\cdot5919913\dot{4}$ .    6.  $4\cdot177\dots$ ;  $304\cdot607209$ .
7.  $4\frac{1}{2}$  per cent.;  $7\frac{7}{8}$  years.    8. £239. 17s. 1d.
9. 23 to 68.

## IX. PAGES 69, 70.

1. 31326, 12710, 18616 cwt.
2. 189 tons 19 cwt. 1 qr. 19 lbs.; 6 lbs.  $6\frac{3}{4}\frac{1}{4}$  oz.
3. £1313. 16s. 3d.    4. £2. 10s. 9d.    5. 11; 252.
6. The fractions are equal to  $\frac{40}{60}$ ,  $\frac{50}{60}$ ,  $\frac{48}{60}$ ,  $\frac{45}{60}$ ,  $\frac{52}{60}$ ,  $\frac{55}{60}$ .
7.  $3\frac{3}{5}$ ;  $1\frac{17}{88}$ .    8.  $\frac{5}{12}$ .    9.  $65\frac{5}{7}$  yds.

**X. PAGES 70, 71.**

1. 46 girls; 104 boys.
2. £4806. 15s.
3. £578. 19s. 1½d.
4.  $1\frac{1}{2}$ ;  $1\frac{43}{77}$ ;  $1\frac{7}{9}$ .
5. £7. 11s. 6d.; £1. 5s. 11½d.; ·5625.
6. 5·774409; 15·349...; 1·442....
7. £551. 0s. 10d.
8. £7882. 6s. 8d.
9. 280½ tons.
10. 13s. 11½d., nearly.

**XI. PAGES 71, 72.**

1. £21; £15. 9s. 2d.
2. 135 tons 4 cwt. 3 qrs. 14 lbs.; 13378 miles 3 fur. 26 pol. 2 ft. 2 in.
3. £329. 19s. 4¾d.
4. £3. 7s. 4½d.
5.  $11\frac{2}{3}$ ;  $4\frac{17}{18}$ ;  $40\frac{32}{33}$ ; 10.
6. ·375; ·35, ·088; ·428571; ·583; ·36.
7. 185; 23·605.
8. £429. 3s. 4d.
9. 8 per cent.

**XII. PAGES 72, 73.**

1. 2²·3·5·7·673; 3·7·19·101; G. C. M. 21;  
L. C. M. 2²·3·5·7·19·101·673.
2. 28.
3. ·00375; ·17857142;  $\frac{259}{1100}$ .
5. 4 tons 1 cwt. 3 qrs. 12 lbs. 12 oz.
6. 15s.
7. £312. 10s.
8. £34. 8s. 11d. nearly.
9. The 4 per cents.; £15400.
10. 4 min. 7½ sec. past 3 P. M.

**XIII. PAGE 73.**

1. ·9999998.
2. ·3535534.
3. £31. 17s. 10½d.
4. £882.
10. £2112.

**XIV. PAGE 74.**

1.  $1\frac{227}{676}$ ; ·063.
2. 7911·7 miles.
3.  $x^2 = \cdot 0000007$ ;  $x^3 = \cdot 0000000$ .
4. £2042. 12s. 10¾d.
5. 186·9949.
7. A, 40, B, 60, C, 120 hours.



**XXI.** PAGES 79, 80.

1. 70905; seventy thousand, nine hundred and five.
2. 211 miles 1 fur. 13 po. 3 yds. 1 ft. 6 in.    3. 13 lbs. 5 oz. 14 dwt.
4.  $\frac{17}{24}$ ;  $\cdot 63\bar{5}$ .    5. 2s.  $1\frac{1}{2}d.$ ;  $\frac{1}{12}$ .    6. £66.
7.  $4\frac{1}{2}$  per cent.    8. £6352. 11s.  $11\frac{1}{2}d.$     9. £23. 3s. 9d.
10. 34·15.    11. £45; £1501. 17s. 6d.
12. Horse £35, cow £14.

**XXII.** PAGES 80, 81.

1. 672927, remainder 1023. Quotient is six hundred and seventy-two thousand, nine hundred and twenty-seven; remainder is one thousand and twenty-three.
2. 600 times.    3.  $1\frac{1009}{10471}$ .    4. £15. 2s. 10d.    5. 16.
6.  $\cdot 06321782$ ;  $\cdot 000006321782$ ; £3. 3s. 6d.    7. £193. 11s.  $7\frac{1}{2}d.$
8. 1s. 6d. gain.    9. Man, 16s. 8d.; woman, 5s. 5d.
10. £9. 7s. 11d.    11.  $4\frac{2}{3}$  per cent.    12. 18 hours.

**XXIII.** PAGES 81, 82.

1. £49. 2s. 6d.    2. (1)  $12\frac{1}{2}$ . (2)  $\frac{5}{11}$ .
3. (1)  $\cdot 273688$ . (2)  $\cdot 002738$ .
4. (1)  $\cdot 543359375$  [5 qrs. = 1 load]. (2) 6 cub. ft. 216 cub. in.
5. £24. 18s.  $6\frac{1}{2}d.$     6. 25 seconds.    7. £1157. 12s. 6d.
8. £150.    9. £2950 [Dividend is £50].
10.  $12\frac{1}{2}$  per cent.    11. 2·882.    12. 480 roubles.

**XXIV.** PAGE 83.

1. £1781. 5s.    2.  $3\frac{1}{2}$  per cent.    3.  $\cdot 018$ ; 180;  $\cdot 00000018$ .
4.  $\cdot 01875$ .    5.  $\frac{1}{7}$ .    6. 4124·952 ounces.
7. £1. 7s. 9d.    8.  $5\frac{1}{8}$  per cent. gain.
9. 17669 times.    10. 27 days.    11. £1714. 15s. 3d.
12.  $\frac{5}{8}$  mile.    13.  $6\frac{3}{29}$ .



3. 3 miles 1 fur. 1 po. 1 yd. 1 ft. 1 in.  
 4. £19. 10s.      5. £5;  $3\frac{5}{9}$ .      6. 20.5; 1 lb.  
 7.  $20\frac{7}{8}$  miles.      8. £35. 3s.  $9\frac{1}{8}d$ .      9.  $2\frac{1}{2}$  per cent.  
 10.  $\frac{7}{9}$ .      11. A, £1. 4s., B, 18s.      12. £3. 17s.

**XXIX.** PAGE 90.

1. One hundred millions, seven hundred and ninety-six thousand, nine hundred and fifty-seven.  
 2. 514800 ounces; 86130 inches.      3. £6. 7s.  $10\frac{3}{4}d$ .  
 4. £52. 15s. 6d.      5.  $10\frac{6}{7}$ .      6. £10. 8s.  
 7. 1296;  $0.02025; \frac{1}{4}$ .      8. £17. 0s. 6d.  
 9. £390. 12s.  $6\frac{3}{4}d$ .      10. A, 15 days, B, 10 days, C, 12 days.  
 11. £4000 stock,  $3\frac{3}{4}$  per cent.      12. 87 and  $43\frac{1}{2}$  yards.

**XXX.** PAGES 91, 92.

1. Five millions two hundred and ninety-nine thousand eight hundred and thirty.  
 2. 119; 17.      3. £12. 15s.  $11\frac{1}{4}d$ .      4.  $2\frac{1}{15}$ ,  $2\frac{1}{6}$ .  
 5.  $\frac{13}{16}$ .      6. £75. 7s.  $9\frac{3}{4}d$ .      7. 005976; 890294.  
 8. 1 ton 15 cwt. 3 qrs.; 13s.      9. 20 days.  
 10. £3661. 13s. 4d.      11.  $18\frac{3}{4}$  per cent.      12.  $93\frac{3}{4}$ .

**XXXI.** PAGES 92, 93.

1. 124 rings.      2. 7 fur. 4 po. 1 ft. 4 in.      3.  $\frac{1}{1512}$ ; 00000001.  
 4.  $5\frac{1}{2}d$ .      5. 5, i.e. the fraction was  $\frac{1}{5}$ .      6. £29. 18s.  $8\frac{3}{4}d$ .  
 7. £272. 5s.      8.  $6\frac{3}{4}$  minutes.      9. £878. 8s.  
 10.  $1437\frac{1}{2}$  bricks.      11.  $3\frac{1}{2}$  per cents.      12. 36.

**XXXII.** PAGES 93, 94, 95.

- |                               |   |
|-------------------------------|---|
| 1. 1727 cub. yds. 26 cub. ft. | 2. £1. 11s. 9d.                                     |
| 3. ·0007285; 30000.           | 4. £122. 2s. 0 $\frac{2}{7}$ $\frac{5}{8}$ d. gain. |
| 5. ·001̄.                     | 6. £45. 8s. 6 $\frac{1}{2}$ d.                      |
| 7. 1.                         | 8. 3 $\frac{1}{2}$ per cent.                        |
| 9. 276 tons.                  | 10. £19398. 15s.; £28 gain.                         |
| 11. 3·231 inches.             | 12. £303. 15s.                                      |

**XXXIII.** PAGES 95, 96.

- |   |   |   |
|---|---|---|
| 1. £5208. 12s. 11 $\frac{3}{4}$ d.; £5313. 8s. 0 $\frac{1}{4}$ d. | 2. $\frac{1}{9}$ .  |   |
| 3. 16; $\frac{71}{900}$ .   | 4. 1609·30.   | 5. £10. 8s. 8 $\frac{1}{4}$ d.; 9·9375. |
| 6. £71. 1s. 5 $\frac{1}{4}$ d.                                    | 7. 0.   |   |
| 8. A, £65. 8s. 9d.; B, £196. 6s. 3d.; C, £261. 15s.               |   |   |
| 9. 20 per cent.   | 10. £2537. 2s. 10 $\frac{3}{4}$ d.; £462. 17s. 1 $\frac{1}{2}$ d. |   |
| 11. 3 $\frac{3}{4}$ minutes; 10 miles an hour.                    | 12. A wins by $\frac{1}{4}$ mile.                                 |   |

**XXXIV.** PAGES 96, 97.

- |   |   |             |
|---|---|-------------|
| 1. Divisor 779, remainder 270.                        | 2. $1\frac{1}{4}$ .                       |             |
| 3. ·5428571̄; ·83; 3648̄.                             | 4. 40 bullocks.                           | 5. 6d.; ·1. |
| 6. 36.  | 7. £1179. 12s. 0 $\frac{1}{2}$ d.         | 8. £250.    |
| 9. £96. 6s.   | 10. 32 $\frac{8}{11}$ minutes past three. |             |
| 11. A and B each receive £111. 2s. 2 $\frac{3}{4}$ d. | 12. £22050.                               |             |

**XXXV.** PAGES 98, 99.

- |                                       |                                  |          |
|---------------------------------------|----------------------------------|----------|
| 1. 1485.                              | 2. $5\frac{283}{1250}$ ; 7·785.  |          |
| 3. 4·16221140132031̄; 267·402597̄.    | 4. 17·8364583̄; $\frac{70}{9}$ . |          |
| 5. £18238. 9s. 6 $\frac{1}{8}$ d.     | 6. £766. 17s. 10d.               |          |
| 7. £605 [= £176 + £198 + £143 + £88]. |                                  |          |
| 8. £179. 5s.; £59. 15s.; £96; £48.    | 9. 1 $\frac{1}{2}$ cwt.          |          |
| 10. 112·64 yards.                     | 11. 5 per cent.                  | 12. £54. |



**XL. PAGE 104.**

- |                         |                    |                    |
|-------------------------|--------------------|--------------------|
| 1. 2184.                | 2. £543. 2s. 1d.   | 3. 3.              |
| 4. 459; 016875; 3.      | 5. 190; 019.       | 6. 24 yds. 2 inch. |
| 7. £675. 10s. 6½d.      | 8. £10. 5s. 0½d.   |                    |
| 9. 780, 468, 520 acres. | 10. £1260; £31010. |                    |

**XLI. PAGE 105.**

- |  |               |                          |                    |
|--|---------------|--------------------------|--------------------|
| 1. 238.  | 2. 8 minutes. | 3. £1. 12s. 6d.          | 4. £5. 4s. 2d.     |
| 5. 501; 501 × 1234 × 1423 = 879746982.                               |               |                          | 6. $\frac{3}{4}$ . |
| 7. 5 ac. 1 ro. 33·414 poles nearly. 162 yds. 1 ft. 7½ inches nearly. |               |                          |                    |
| 8. £11. 8s.  |               | 9. £75. 19s. 3d. nearly. |                    |
| 10. 3¼ per cent.; 3½ per cent.; 3¼ per cent.                         |               |                          |                    |

**XLII. PAGES 106, 107.**

- |                          |                          |                    |                          |
|--------------------------|--------------------------|--------------------|--------------------------|
| 1. $11\frac{229}{260}$ . | 2. $6\frac{121}{150}$ .  | 3. $\frac{2}{7}$ . | 4. $4\frac{1}{2}$ .      |
| 5. 547·12625.            | 6. 13·20554.             | 7. 04682199075.    |                          |
| 8. 13·75.                | 9. 34375 cwt.            | 10. 199 lbs.       | 11. 142686 sq. ft.       |
| 12. £34. 5s. 3¾d.        | 13. $6\frac{395}{432}$ . |                    | 14. $3\frac{443}{650}$ . |
| 15. $\frac{32}{55}$ .    | 16. $\frac{9}{80}$ .     |                    | 17. 401·88 min.          |
| 18. 33·3006 pence.       | 19. 58·101136571.        | 20. 4·9435266821.  |                          |
| 21. 059106.              | 22. 675.                 | 23. 3½ per cent.   |                          |
| 24. £42.                 | 25. £12290. 16s.         | 26. 16 days.       |                          |

**XLIII. PAGES 107, 108, 109.**

- |                         |  |                         |
|-------------------------|--|-------------------------|
| 1. $6\frac{139}{180}$ . | 2. $3\frac{119}{320}$ .                    | 3. 45.                  |
| 4. $1\frac{11}{45}$ .   | 5. 1290·657788.                            | 6. 8·828865.            |
| 7. 210·955063285.       | 8. 003764.                                 | 9. 62749·677375.        |
| 10. 4s. 3¾d.            | 11. 2 mi. 1 fur. 0 po. 0 yds. 2 ft. 11 in. |                         |
| 12. £126. 11s. 3d.      | 13. $10\frac{619}{1020}$ .                 | 14. $7\frac{76}{189}$ . |

- |     |  |     |                              |     |                     |
|-----|--|-----|------------------------------|-----|---------------------|
| 15. | $27\frac{1}{2}$ .                                | 16. | $\frac{2}{9}$ .              | 17. | .779415.            |
| 18. | 22.4 pints.                                      | 19. | .031203429.                  | 20. | .504.               |
| 21. | 6.7246.  | 22. | .03125.                      | 23. | $4\frac{1}{2}$ yrs. |
| 24. | $26\frac{1}{4}$ ; £6. 17s. 9 $\frac{3}{4}$ d.    | 25. | £119. 7s. 4 $\frac{1}{2}$ d. |     |                     |
| 26. | 5 hours. A, 17 $\frac{1}{2}$ miles; B, 20 miles. |     |                              |     |                     |

## XLIV. PAGES 109, 110.

- |     |                        |     |                                |     |                               |
|-----|------------------------|-----|--------------------------------|-----|-------------------------------|
| 1.  | $8\frac{1423}{1680}$ . | 2.  | $10\frac{80}{189}$ .           | 3.  | $3\frac{3}{8}$ .              |
| 4.  | $2\frac{1}{10}$ .      | 5.  | 332.72973.                     | 6.  | 44.54408.                     |
| 7.  | .0893443635.           | 8.  | 43.25.                         | 9.  | 194.8808 lbs.                 |
| 10. | £3. 14s. 6d.           | 11. | 27729 ft.                      | 12. | £38. 17s. 5 $\frac{1}{10}$ d. |
| 13. | $9\frac{283}{810}$ .   | 14. | $13\frac{107}{315}$ .          | 15. | 4.                            |
| 16. | $\frac{3}{28}$ .       | 17. | 3095.848125 sq. ft.            |     |                               |
| 18. | 2253.456 min.          | 19. | .624850119.                    | 20. | 418.7496.                     |
| 21. | .07088.                | 22. | .0775.                         | 23. | $6\frac{1}{2}$ years.         |
| 24. | 12 hours.              | 25. | £4730. 10s. 4 $\frac{1}{2}$ d. | 26. | 18s. 9d.                      |

## XLV. PAGES 110, 111, 112.

- |     |                       |     |                        |     |                    |
|-----|-----------------------|-----|------------------------|-----|--------------------|
| 1.  | $9\frac{767}{2772}$ . | 2.  | $1\frac{43}{44}$ .     | 3.  | $\frac{33}{169}$ . |
| 4.  | $\frac{121}{175}$ .   | 5.  | 103.253837.            | 6.  | 1.222231.          |
| 7.  | 1110038584.           | 8.  | 3174.43.               | 9.  | 6197.090625.       |
| 10. | $\frac{55}{266}$ .    | 11. | 168813 qrs.            | 12. | £30. 7s. 9d.       |
| 13. | $5\frac{697}{875}$ .  | 14. | $3\frac{116}{195}$ .   | 15. | $1\frac{7}{8}$ .   |
| 16. | $\frac{8}{35}$ .      | 17. | 88 frs. 93 c.          | 18. | 9.86042 miles.     |
| 19. | 5.3299568121.         | 20. | .22272495.             | 21. | .13719.            |
| 22. | 4.954.                | 23. | 2 $\frac{3}{4}$ years. |     |                    |

24. *A*, £16. 4s. 3d.; *B*, £13. 5s. 8d.; *C*, £11. 7s. 6d.  
 25. £881. 9s.  
 26. The fractions are in ascending order of magnitude. 33  
103

## XLVI. PAGES 112, 113.

- |   |                                  |                          |
|---|----------------------------------|--------------------------|
| 1. $13\frac{15}{52}$ .                          | 2. $\frac{241}{280}$ .           | 3. $24\frac{1}{16}$ .    |
| 4. $\frac{13}{36}$ .                            | 5. 70·1307181.                   | 6. ·909109.              |
| 7. 5·2016337660.                                | 8. 700·86.                       | 9. 174661·725 inches.    |
| 10. $\frac{23}{168}$ .                          | 11. 686247 $\frac{3}{4}$ sq. ft. | 12. £178. 8s. 10d.       |
| 13. $8\frac{13}{44}$ .                          | 14. $4\frac{195}{196}$ .         | 15. $\frac{15}{22}$ .    |
| 16. $3\frac{1}{2}$ .                            | 17. £2·3296.                     | 18. £11·502625.          |
| 19. 2·8245752184.                               | 20. ·767.                        | 21. ·060504.             |
| 22. ·108.                                       | 23. £315. 10s. 8d.               |                          |
| 24. Boy, 10s. 6d.; woman, £1. 1s.; man, £3. 3s. |                                  |                          |
| 25. £3659. 6s. 10 $\frac{1}{2}$ d.              |                                  | 26. $8\frac{178}{661}$ . |

## XLVII. PAGES 114, 115.

- |   |   |                                  |
|---|---|----------------------------------|
| 1. $10\frac{37}{63}$ .                          | 2. $3\frac{29}{78}$ .                       | 3. $8\frac{2}{5}$ .              |
| 4. $\frac{1}{32}$ .                             | 5. 406·449933.                              | 6. 94·9700881.                   |
| 7. ·412340073159.                               | 8. ·005107.                                 | 9. 173·34033 pints.              |
| 10. ·564375.                                    | 11. 13 ac. 1 r. 30 po. 12 yds. 0 ft. 50 in. |                                  |
| 12. 5 $\frac{3}{4}$ per cent.                   | 13. $12\frac{4}{5}$ .                       | 14. $110\frac{152}{165}$ .       |
| 15. $40\frac{1}{3}$ .                           | 16. $\frac{1}{21}$ .                        | 17. 61·5128 lbs.                 |
| 18. $1380\frac{10}{11}$ English acres.          |   | 19. ·1481882853.                 |
| 20. 1·644.                                      | 21. 12·54.                                  | 22. 34·015 $\dot{3}$ .           |
| 23. 18s. 9d.                                    | 24. 142800.                                 | 25. £507. 8s. 2 $\frac{1}{2}$ d. |
| 26. 80 half-crowns; 160 florins; 240 shillings. |   |                                  |

**XLVIII.** PAGES 115, 116, 117.

- |     |   |     |   |     |                      |
|-----|---|-----|---|-----|----------------------|
| 1.  | $69\frac{121}{420}$ .                   | 2.  | $4\frac{29}{42}$ .                                | 3.  | 6.                   |
| 4.  | $8\frac{8}{9}$ .                        | 5.  | 387·32926401.                                     | 6.  | 60·108375.           |
| 7.  | 4·4106306765.                           | 8.  | ·005803.  | 9.  | 101721·2634 inches.  |
| 10. | ·075.                                   | 11. | 1 ac. 1 r. 15 po. 5 sq. yds. 3 sq. ft. 26 sq. in. |     |                      |
| 12. | £308. 6s. 10½ <i>d.</i>                 | 12. | $58\frac{155}{306}$ .                             | 14. | $1\frac{157}{306}$ . |
| 15. | 1.                                      | 16. | $14\frac{2}{15}$ .                                | 17. | 30201·492 grains.    |
| 18. | 36·57336 pints.                         | 19. | 3·34931292023.                                    | 20. | ·57.                 |
| 21. | 31·012.                                 | 22. | ·2.   | 23. | £1525.               |
| 24. | 11 days.                                | 25. | £3348. 16s. 10½ <i>d.</i>                         |     |                      |
| 26. | 3 days 14 hours 43 min. 35·904 seconds. |     |   |     |                      |

**XLIX.** PAGES 117, 118.

- |     |                                     |     |                         |     |                       |
|-----|-------------------------------------|-----|-------------------------|-----|-----------------------|
| 1.  | $19\frac{133}{240}$ .               | 2.  | $9\frac{1259}{1728}$ .  | 3.  | $16\frac{1}{4}$ .     |
| 4.  | $3\frac{3}{4}$ .                    | 5.  | 433·50198.              | 6.  | 35·95277.             |
| 7.  | ·049265256.                         | 8.  | ·04705.                 | 9.  | 25708·572 grains.     |
| 10. | 64 m. 2 f. 28 p. 3 yds. 0 ft. 5 in. | 11. | ·3698.                  |     |                       |
| 12. | £434. 13s. 5 <i>d.</i>              | 13. | $34\frac{79}{312}$ .    | 14. | $28\frac{59}{228}$ .  |
| 15. | $13\frac{1}{3}$ .                   | 16. | $1\frac{1}{27}$ .       | 17. | 8285·76 ozs.          |
| 18. | 2161·06 sq. yds.                    | 19. | 10·84588703.            | 20. | 1·645.                |
| 21. | 108·87816.                          | 22. | 14·14.                  | 23. | $3\frac{1}{2}$ years. |
| 24. | £103. 4s.                           | 25. | £663. 1s. 10⅞ <i>d.</i> | 26. | ·00275.               |

**L.** PAGES 119, 120.

- |    |                   |    |                     |    |                  |
|----|-------------------|----|---------------------|----|------------------|
| 1. | $7\frac{6}{35}$ . | 2. | $2\frac{65}{136}$ . | 3. | $\frac{2}{15}$ . |
| 4. | $\frac{7}{40}$ .  | 5. | 396·294888.         | 6. | 662·983028.      |
| 7. | 1·154212711.      | 8. | ·3606.              | 9. | 21421·62 min.    |

- |                           |                           |                        |
|---------------------------|---------------------------|------------------------|
| 10. 5 m. 3 f. 36 p. 5 in. |                           | 11. £94.               |
| 12. £838. 2s. 6d.         | 13. $10 \frac{17}{280}$ . | 14. $3 \frac{3}{22}$ . |
| 15. $3 \frac{3}{4}$ .     | 16. $1 \frac{32}{45}$ .   | 17. 759·725 pence.     |
| 18. ·054.                 | 19. 25.                   | 20. ·0625.             |
| 21. £178. 14s. 1½d.       | 22. $\frac{14}{27}$ .     |                        |

**LI. PAGES 120, 121.**

- |                      |                       |                                  |
|----------------------|-----------------------|----------------------------------|
| 1. £3385. 1s. 9d.    | 2. $\frac{17}{171}$ . | 3. 32.                           |
| 4. $24\frac{1}{2}$ . | 5. 12; 144144.        | 6. (i) $\frac{9}{889}$ ; (ii) 1. |

**LII. PAGE 122.**

- |                         |   |              |
|-------------------------|---|--------------|
| 2. $6\frac{1}{6}$ days. | 3. May 15th, 1908.                          | 4. 11364896. |
| 5. (i) 1; (ii) 125.     | 6. Man, £11. 2s. 9d.; Woman, £6. 9s. 11¼d.; |              |

**LIII. PAGES 123, 124.**

- |   |  |  |
|---|--|--|
| 1. 4005; rem. 607.  | 2. $2^4 \times 11 \times 7^2 \times 3 \times 5^3$ ; $3^3 \times 7 \times 2^5 \times 5^2$ . |  |
| L. C. M. = $2^5 \times 3^3 \times 5^2 \times 11 \times 7^2 = 2852388$ . |  |  |
| 3. 1 min. $22\frac{1}{4}$ sec.  | 4. 17 ft. 4 in.  | 5. £1. 15s. 3d.                                  |
| 6. $\frac{1}{7}$ .  | 7. (i) $4\frac{1}{2}$ ; (ii) $\frac{7}{67}$ .  | 8. (i) $\frac{23}{28}$ ; (ii) $\frac{17}{180}$ . |
| 9. $2\frac{3}{5}$ .   | 10. 11s. $6\frac{3}{4}$ d. nearly.   | 11. 4486½ gals.                                  |

**LIV.** PAGES 124, 125.

- |   |                         |                           |
|---|-------------------------|---------------------------|
| 1. Apples 2 for 1 <i>d.</i> ; oranges 3 for 1 <i>d.</i> | 2. $30\frac{5}{4}$ .    |                           |
| 3. 109·41 sq. in.                                       | 4. 54 lbs.              | 5. £24. 5 <i>s.</i> loss. |
| 6. (i) 78; (ii) 100 lbs. = 3 qrs. 16 lbs.               | 7. £9526.               |                           |
| 8. $36\frac{5}{8}$ .                                    | 9. ·052631578947368421. | 10. $5\frac{3}{8}$ secs.  |

**LV.** PAGES 125, 126.

- |  |   |                             |
|--|---|-----------------------------|
| 1. £104534. 6 <i>s.</i> 6 <i>d.</i>  | 2. 619,699,000.   |                             |
| 3. $3^2 \times 2^3 \times 5^2$ ; $7^2 \times 5^2$ ; $3^3 \times 5 \times 7$ . L. C. M. = $3^3 \times 2^3 \times 5^2 \times 7^2 = 12965400$ . |   |                             |
| 4. 8.  | 5. (i) $\frac{2}{3}$ ; (ii) $\frac{1}{35}$ .                        | 6. 240.                     |
| 7. ·875, ·112, ·1, ·461538.  | $\frac{5}{8}$ , $\frac{39}{125}$ , $\frac{1}{3}$ , $\frac{1}{27}$ . |                             |
| 8. (i) $6\frac{1}{2}$ ; (ii) 1·25.   | 9. (i) $\frac{55}{76}$ ; (ii) ·278125.                              | 10. 9 <i>s.</i> 4 <i>d.</i> |

**LVI.** PAGES 126, 127.

- |                |                        |                        |
|----------------|------------------------|------------------------|
| 1. 5000; 4990. | 2. $\frac{238}{255}$ . | 3. $114\frac{7}{12}$ . |
|----------------|------------------------|------------------------|

**LVII.** PAGES 128, 129.

- |  |   |                                      |
|--|---|--------------------------------------|
| 1. 459613.   | 2. £76. 5 <i>s.</i> 4 <i>d.</i>           | 3. £145. 10 <i>s.</i>                |
| 4. £104. 3 <i>s.</i> 5 <i>d.</i> (to the nearest penny). | 5. £16. 4 <i>s.</i> 9 <i>d.</i>           |                                      |
| 6. 205 yds. 1 ft.  | 7. $\frac{9}{25}$ ; $\frac{1237}{2371}$ . | 8. (i) $6\frac{7}{8}$ ; (ii) 5000·7. |

**LVIII.** PAGES 129, 130.

- |  |                                 |  |
|--|---------------------------------|--|
| 1. 19. $19 \times 29 \times 13$ . $19 \times 23 \times 17$ . | 2. 339·72.                      | 3. 20692.  |
| 4. 2·887.  | 5. ·03398. $51\frac{1}{2}$ yds. | 6. $1\frac{1}{2}$ .  |
| 7. £4417. 10 <i>s.</i>                                       | 8. £545. 8 <i>s.</i>            | 9. $\frac{3}{13}$ , $\frac{9}{13}$ , $\frac{10}{13}$ , $\frac{12}{13}$ . |

## LOGARITHMS AND MENSURATION.

## I. PAGES 136, 137.

1. £6768, 7s.  $10\frac{1}{4}d.$
2. 1·0034606; 9·076226.
3. 46·58847.
4. 48 sq. ft.  $134\frac{1}{2}$  sq. in.
5. 25 chains.
6.  $6\frac{3}{4}$  acres.
7.  $64\frac{7}{7}$  sq. poles.
8.  $\frac{160}{\pi} = 50\cdot928$  acres.
9. 11·69 sq. in. nearly.
10. 150, 200, 250 yards; 45000 sq. yds.

## II. PAGES 137, 138.

1.  $\bar{3}\cdot3222194$ ; 4·3346346; 1·9451522.
2. 8·08147.
3. £11434. 2s.  $1\frac{1}{4}d.$
4. 15 acres.
5.  $64\pi = 201\cdot0624$  sq. miles.
6. 105 cub. ft.  $2'4''3'''6''2'' = 105$  cub. ft.  $339\frac{3}{4}$  cub. in.
7.  $640\sqrt{\pi} = 1134\cdot08$  yds.
8. 33·6 ft.
9. 2513·28 cub. ft.
10. 4·54 litres.

## III. PAGE 138.

1. 1·063.
2.  $22\frac{1}{2}$  years, nearly.
3. 32·05.
4. 11·46; 9; 6·93 sq. inches.
5. 3·968626 acres; 6·614378 chains.
6. 50 cub. ft.  $6'6''10'''10''6' \Rightarrow 50$  cub. ft.  $946\frac{1}{2}$  cub. in.
7.  $\frac{180\sqrt{3}}{121} = 2\cdot57$  acres.
8. 1353 cub. in.
9.  $16\pi = 50\cdot2656$  lbs.
10. One inch.

## IV. PAGE 139.

1. 2·15443.                      2. A little less than 9 years.  
 3. 178·141516.                4. £78. 8s.            5. 10 ft. 9 in.; 99846 sq. in.  
 6. Nearly 2·45 inches a minute.                      7. 33600 sq. ft.  
 8. 709½ lbs.                    9.  $100\sqrt{2} = 141·4$  ft.            10. £16. 13s. 4d.

## V. PAGE 140.

1. 2·08979.                      2. 855677.                      3.  $\frac{3}{2c}$ .  
 4. 36960 sq. yds.                5. £512. 17s. 8½¼d.  
 6. 6 sq. ft. 16 sq. in. [=280π sq. in.].                7. 53½ sq. yds.  
 8. £858. 15s. 3d. nearly.                      9. 667½ cub. in.  
 10.  $\sqrt[3]{\frac{3}{4\pi}} = \cdot 62$  inches. [Internal and external radii are  $8\sqrt[3]{\frac{3}{4\pi}}$   
 and  $9\sqrt[3]{\frac{3}{4\pi}}$  respectively.]

## VI. PAGE 141.

1. ·8450980; ·3010300; ·4771213.                      2. 19008.  
 3. About 125 years.            4. 80 cub. yds. 3 cub. ft.  $379\frac{1}{1}\frac{1}{2}\frac{1}{2}$  cub. in.  
 5.  $\frac{50}{\sqrt{\pi}} = 28·21$  ft.                6. 1403 lbs. nearly.            7.  $6\frac{1}{4}$  ft.  
 8. 5 cub. ft. 408 cub. in.                      9. 8 to 1.                      10. 3328 tiles.

## VII. PAGE 142.

1. 3. [Numerator = 9 log 12; denominator = log 12.]  
 2. ·8562427.                      3.  $x = 7·04$ .                      4. 9·24 acres.  
 5. 12432 [=17472 - 5040].                      6. 450 lbs.  
 7.  $\sqrt[3]{\frac{3}{4\pi}}$  to 1; or as 31 to 50.                      .  
 8.  $77\frac{1}{2}$  cub. ft. = 77 cub. ft. 1649½ cub. in.                      .  
 9. £10. 11s. 6d.; 7920.                      10. 7 : 19 : 37.

## VIII. PAGE 143.

1.  $2\cdot3222193$ ;  $\bar{1}\cdot1367499$ ;  $\cdot5204397$ .      2.  $x=3\cdot97$ .
3.  $\cdot906015$  miles per hour.      4.  $1221$  sq. ft.  $83\frac{1}{2}$  sq. in.
5.  $20000$  sovereigns.      6.  $35, 35, 42$  yards.      7.  $4\cdot1888$  cub. ft.
8.  $1145\cdot45$ ;  $692\cdot8$ ;  $900$ ;  $1039\cdot2$  sq. ft.
9.  $1\frac{1}{2}$  inches.      10.  $235\cdot62$  sq. in.

## IX. PAGE 144.

1.  $3$ ;  $-\frac{2}{3}$ ;  $-\frac{3}{2}$ ;  $\frac{4}{3}$ .      2.  $\cdot698970$ ;  $\cdot845098$ ;  $1\cdot113943$ .
3.  $\bar{1}\cdot1163460$ ;  $\cdot9163136$ ;  $6\cdot461219$ .      4.  $15\cdot093$  inches.
5.  $\cdot248$  acres.      6. *2s. 6d.*      7.  $1750$  bullets.
8.  $133\frac{2}{3}$  yds.      9.  $2$  to  $5$ .      10.  $11\frac{2}{3}\frac{1}{2}$  ft.

## X. PAGE 145.

1.  $6$ ;  $2$ ;  $3$ .      2.  $\cdot6443935$ .
3. A little more than  $10$  years.      4.  $421$  cub. ft.  $1512$  cub. in.
5.  $7$  chains  $70$  links.      6.  $4$  ft.  $1$  in.
7.  $8$  to  $17$ .      8.  $12$  yds.      9.  $\cdot927$  in.

## XI. PAGE 146.

1.  $1\cdot3979400$ ;  $\bar{2}\cdot4948500$ ;  $\bar{1}\cdot6795880$ .
2.  $x = -\frac{\log 3}{\log 2 + \log 3} = -\cdot613$ ;  $y = \frac{\log 2}{\log 2 + \log 3} = \cdot386$ .
3.  $8478\cdot024$ .      4.  $10\cdot032$  cub. ft.;  $7\cdot392$  cub. ft.
5.  $2\sqrt{\pi} = 3\cdot544$  miles . . . .      6.  $3$  ft.  $6$  in.
7.  $94\cdot032$  cub. in.      8.  $12\pi = 37\cdot6992$  sq. in.
9.  $3769\cdot92$  cub. in.;  $1319\cdot472$  sq. in.
10.  $36\pi - 24\sqrt{3} = 71\cdot5296$  cub. ft.

**XII.** PAGES 146, 147.

1.  $x = 1.06$ .
2.  $\sqrt{3802113}$ ;  $9.4768640$ ;  $.4610087$ ;  $1314.56$ .
3.  $1.2304489$  [put  $n = 120$ ].
4.  $3\sqrt{3}$  guineas = £5. 9s.  $1\frac{1}{2}d$ . nearly.
5.  $84$  sq. ft.;  $12\frac{1}{2}$ ,  $12$ ,  $11\frac{1}{2}$  ft.      6.  $968$  yds.
7.  $5120$  minutes =  $3$  days  $13$  hours  $20$  minutes.
8.  $7$  ft.      9.  $7125$  oz.
10.  $\frac{20000\pi}{3} = 20944$  lbs.;  $\frac{32\pi}{45}(2 + \sqrt{10}) = 11.532$  lbs.

**XIII.** PAGES 148, 149.

1.  $14.67797$ .      2.  $x = 1.177$ ,  $y = .677$
- |   |  |
|---|--|
| putting $a$ for $\log 2$ and $b$ for $\log 3$ , | $\frac{x}{3b - 2a} = \frac{y}{b} = \frac{1}{4(b - a)}$ |
|---|--|
3.  $1.6334685$  [put  $n = 300$ ].      4.  $6$  ft.; £10. 14s. 6d.
5.  $42$  ft.      6.  $\sqrt{3 - \frac{\pi}{2}} = .1612$  sq. ft.
7.  $95700$  sq. yds. =  $19$  acres  $3$  roods  $3\frac{1}{4}$  poles.
8.  $2244$  lbs. =  $1$  ton  $4$  lbs.      9.  $106$  ft.      10.  $83.776$  sq. ft.

**XIV.** PAGE 149.

1.  $.885$ ;  $1.129$ .      2.  $1.389494$ .      3.  $120$  sq. in.
4.  $93391360$  cub. ft.      5.  $50.2656$  lbs. =  $50$  lbs.  $4\frac{1}{2}$  oz. nearly.
6.  $10602$  cub. ft.      7.  $11.6$  in.      8.  $6$  ft.  $9$  in.;  $9$  ft.
9.  $212\frac{3}{8}$  yds.      10.  $6 - \sqrt[3]{84} = 1.62$  in.

**XV.** PAGE 150.

1.  $2.3876389$ ; 2.  $.6989700$ ;  $.8450980$ ;  $.9030900$ ;  $.9542425$ .
3.  $6$  inches per minute;  $15$  min.      4.  $7$  ft.
5.  $66$  lbs.  $10\frac{1}{2}$  oz.      6.  $\frac{1536}{\pi} = 489.5$  sq. ft. nearly;  $64$  ft.
7.  $7\frac{5}{8}$  cub. ft.      8.  $10$  ft.
9.  $2(\sqrt[3]{2} - 1) = .52$  in.;  $2(\sqrt{2} - 1) = .828$  in. [ $\sqrt[3]{2} = 1.26$ ].
10.  $\frac{11375\pi}{24} = 1489$  lbs. nearly

**XVI.** PAGES 151, 152.

1. £1130. 13s. 4d.
2.  $\bar{1}\cdot8920947$ ;  $\bar{3}\cdot5910647$ ;  $8\cdot496253$ .
3.  $30 + 78\sqrt{2}$  sq. ft. = 140 sq. ft. 42·048 sq. in.
4. 103·2 acres.
5.  $206\frac{1}{4}$  lbs.
6.  $3136\pi = 9852$  sq. in.
7.  $\frac{417\pi}{16} = 81\cdot878$  cub. ft.
8. 1353 cub. in.
9. 9s.  $4\frac{1}{2}d$ .
10.  $67\frac{1}{2}$  ft.

**XVII.** PAGES 152, 153.

1.  $1 + 4 \log 3 + \log 7 = 3\cdot7535832$ .
2. 4·37952.
3.  $\frac{1}{4\pi} = \cdot0796$  sq. yds.
4. 23520 bullets.
5. 10800 sq. yds. = 2 acres 37 poles  $\frac{3}{4}$  sq. yd.
6. 1536 lbs.
7. 533 ft.
8. 202000 gallons.
9.  $24$  cub. ft. short.
10. 380 sq. yds. nearly.

**XVIII.** PAGE 153.

1. 125·467.
2.  $4 \log 3 - 6 \log 2 = \cdot1023052$ .
3. 4200 cub. ft.
4. 13 ft.
5. 4 inches to the mile.
6. 6 cwt.  $15\frac{1}{2}$  lbs.
7. 53·67 sq. yds. [radius =  $10 \sqrt[3]{\frac{3}{4\pi}} = 6\cdot2$  ft.].
8.  $126\frac{3}{4}$  cub. ft.
9. 18 inches.
10.  $10\pi = 31\cdot416$  cub. ft. [Since height of cone + height of hemisphere is greater than height of cylinder, the solid is only partially immersed.]

**XIX.** PAGES 154, 155.

1. 2·174773.
2. Expression =  $\frac{\frac{3}{2} \log 3 + 3 \log 2 - \frac{3}{2}}{\log 3 + 2 \log 2 - 1} = \frac{3}{2}$ .
3.  $\log_2 2 = 1$ .
4. 80000.
5. 64 lbs.
6. ·02 in.; ·000075 sq. in.
7. £9. 18s.
8.  $2292\frac{3}{4}$  cub. ft.; 173 tons 19 cwt. 1 qr.  $27\frac{3}{4}$  lbs.
9. 11 tons.
10.  $(432 - 32\pi)\sqrt{3} = 574\cdot1$  cub. in. [radius of sphere =  $2\sqrt{3}$  in.].

**XX. PAGES 155, 156.**

1.  $1 - \log 2 + \log 3 + \log 7 = .9895$ . Diff. for 1 = 217;  $\bar{1} \cdot 3010491$ .
2.  $\log 37 = 1.5682017$   
[ $999 = 37 \times 27$ , put  $n = 1000$  in the second series].  
 $\log 53 = 1.7242759$  [ $901 = 53 \times 17$ , put  $n = 900$  in the first series].
3.  $54\frac{7}{8}$  lbs.                      4.  $3\sqrt[3]{91} = 28.617$  sq. ft. nearly.
5. 2.598 cub. ft.; 16.237 gallons.
6.  $\frac{7168\pi}{1125} = 20.017$  cub. in.              7.  $21000\sqrt[3]{3} = 36372$  cub. ft.
8. 250 sq. in.; 9.6 in.              9.  $\frac{\pi}{3}$  cub. ft. = 1 cub. ft. 82 cub. in.
10.  $18\pi = 56.5488$  sq. in.

**XXI. PAGE 157.**

1. .00141327.                      2. .5612934.                      3. .519572.
4. .0000130834.                      5. .546837.                      6. £1515. 12s.
7. 3.05864.                      8. 1507.352 ft.                      9. 23.952 in.
10.  $\frac{40}{\sqrt{\pi}} = 22.5675$  yds.

**XXII. PAGE 157, 158.**

1. .2261133.                      2. 1431.803.                      3. .002016227.
4. 26.51161.                      5. 10.3911.                      6. 759.899.
7.  $91^\circ 52' 43.6''$ .                      8. 178698.                      9. 11.7157 miles.
10.  $194.0083$  sq. in.

**XXIII. PAGE 158.**

1. .0000056.                      2. 4165.575.                      3. 34.83745.
4. 1.581139.                      5. .0001128889.                      6. £4. 16s. 1d.
7. 33.465 ft.                      8. 195883 sq. ft.                      9. 114.0034 ft.
10. 6237.422 cub. ft.

**XXIV. PAGE 159.**

1. 22.5.                      2. 15.54857.                      3. .9492327.
4. 2199541.                      5. .5271942.                      6. 19.
7. 3.5568 acres.                      8. 218.603 ft., 10930.15 sq. ft.
9.  $6^\circ 32' 43''$ .                      10. 8s.  $3\frac{1}{2}d$ .

**XXV.** PAGE 159, 160.

- |   |                   |              |
|---|-------------------|--------------|
| 1. 83·725.  | 2. 8·291742.      | 3. ·8822875. |
| 4. 39·989.  | 5. £1362. 1s. 8d. | 6. 12.       |
| 7. 11·754 cub. in.  | 8. 4·33432 ft.    |              |
| 9. $A = 67^\circ 48' 26''$ , or $112^\circ 11' 34''$ , $C = 73^\circ 31' 34''$ , or $29^\circ 8' 26''$<br>$c = 181\cdot3257$ or $92\cdot0771$ . |                   |              |
|   | 10. 1·41214.      |              |

**XXVI.** PAGE 160, 161.

- |  |                             |                 |
|--|-----------------------------|-----------------|
| 1. ·04468605.                                    | 2. ·41063.                  | 3. ·1126065.    |
| 4. ·5271942.                                     | 5. $4\frac{1}{2}$ per cent. | 6. 6383·135.    |
| 7. $32^\circ 43' 29''$ or $147^\circ 16' 31''$ . |                             | 8. 25·7834 yds. |
| 9. 6·48385.                                      | 10. 1097·476.               |                 |

**XXVII.** PAGE 161.

- |                             |  |             |
|-----------------------------|--|-------------|
| 1. 3·79729.                 | 2. 1·141102.                                   | 3. 575·775. |
| 4. 5 per cent.              | 5. 188·1162 sq. yds.                           | 6. 47·8335. |
| 7. 2, 7·123105, - 1·123105. |  | 8. 2·78496. |
| 9. 2·67496.                 | 10. diam. = 4·25 ft.; surf. = 695·9625 sq. ft. |             |

**XXVIII.** PAGE 161, 162.

- |                   |              |                 |
|-------------------|--------------|-----------------|
| 1. ·00191781.     | 2. 145·058.  | 3. 1·556766 ft. |
| 4. £2848. 2s. 9d. | 5. 195·6958. | 6. 269·5883.    |
| 7. 1409·029 yds.  | 8. 374·4 ft. | 9. 618·242 in.  |
| 10. 9 in.         |              |                 |

**XXIX.** PAGE 162, 163.

- |  |                     |            |
|--|---------------------|------------|
| 1. ·6254953, ·6386461.                       | 2. 2·100840.        |            |
| 3. £680. 10s.                                | 4. 26·95057 sq. ft. | 5. 100 ft. |
| 6. $6^\circ 52' 14''$ .                      | 8. 5775 93 yds.     |            |
| 9. (1) 77·329-sq. yds. (2) 26·2708 cub. yds. | 10. 2·1768 ft.      |            |

**XXX.** PAGE 163, 164.

- |                              |                 |                    |
|------------------------------|-----------------|--------------------|
| 1. .02162658.                | 2. .994222.     | 3. £4341. 12s. 1d. |
| 4. $91^{\circ} 52' 43.6''$ . | 6. 140.5069 in. | 7. 1122.243 yds.   |
| 8. 2.6718 miles per hour.    | 9. 45534.14.    |                    |
10. 29179 ft.; 17507.4 ft.

**XXXI.** PAGES 164, 165.

- |   |                                |                   |
|---|--------------------------------|-------------------|
| 1. 4499.832; 2.020898.                    | 2. 4.6166721.                  | 3. £2931. 4s. 9d. |
| 4. 8.                                     | 5. 522.74 in.; 61417.5 sq. in. |                   |
| 6. $49^{\circ} 28' 26''$ ; area = 833.46. | 7. 96.8967 in.                 |                   |
| 8. 229.149 yds.                           | 9. 9421.36 sq. in.             | 10. £2. 2s. 8d.   |

**XXXII.** PAGES 165, 166.

- |  |                      |                  |
|--|----------------------|------------------|
| 1. 2.345058.   | 2. 104 yrs. nearly.  | 3. 7415.655.     |
| 4. £6768. 7s. $10\frac{1}{2}$ d.                       | 5. 58.218 in.        | 6. 118.19287 in. |
| 7. 25.7834 yds.  |                      |                  |
| 8. Area = 101543.375 sq. ft., Circumf. = 1129.6157 ft. |                      |                  |
| 9. 11329 cub. in.                                      | 10. 415.474 cub. in. |                  |

**XXXIII.** PAGES 166, 167.

- |                                    |   |        |
|------------------------------------|---|--------|
| 1. (1) 198.5366. (2) 8.828884.     | 2. 39.405.  | 3. 20. |
| 4. £12152.84 = £12152. 16s. 9d.    | 5. 32.871053 yds.                                     |        |
| 6. 18.36413 miles, 32.64895 miles. | 7. 205 sq. ft. 141 sq. in.                            |        |
| 8. 23.511343.                      | 9. $\Delta = 69.9748$ , $R = 7.9627$ , $r = 3.5199$ . |        |
10.  $r_1 = 11.3595$ ,  $r_2 = 16.6606$ ,  $r_3 = 7.3503$ ,  
 $4R = 31.8508$ ;  $r_1 + r_2 + r_3 - r = 31.8506$ .

**XXXIV.** PAGES 167, 168.

- |                                |                         |                       |
|--------------------------------|-------------------------|-----------------------|
| 1. 2.079383.                   | 2. 2.0118965.           | 3. 25.59005.          |
| 4. 682.0425 yds.               | 5. 17.1064 sq. in.      | 6. 218.96936 cub. ft. |
| 7. £115. 9s. 7d. nearly.       | 8. £7. 16s. 8d. nearly. |                       |
| 9. 16 cwt. 1 qr. 14 lbs. 8 oz. | 10. 3923.08 cub. ft.    |                       |

**XXXV.** PAGE 168.

- |                                    |                                |                      |
|------------------------------------|--------------------------------|----------------------|
| 1. 9.52912.                        | 2. .001113725.                 | 3. 1149.8392.        |
| 4. 104.63 sq. in.                  | 5. 1.628675 ft.                | 6. 51904.77 cub. ft. |
| 7. .7535 pint.                     | 8. 1751.027 yds.; 7401.37 yds. |                      |
| 9. 311.4182 cub. ft.; £2. 19s. 9d. | 10. 100.                       |                      |

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