

**CIHM
Microfiche
Series
(Monographs)**

**ICMH
Collection de
microfiches
(monographies)**



Canadian Institute for Historical Microreproductions / Institut canadien de microreproductions historiques

© 1994

Technical and Bibliographic Notes / Notes techniques et bibliographiques

The Institute has attempted to obtain the best original copy available for filming. Features of this copy which may be bibliographically unique, which may alter any of the images in the reproduction, or which may significantly change the usual method of filming, are checked below.

L'Institut a microfilmé le meilleur exemplaire qu'il lui a été possible de se procurer. Les détails de cet exemplaire qui sont peut-être uniques du point de vue bibliographique, qui peuvent modifier une image reproduite, ou qui peuvent exiger une modification dans la méthode normale de filmage sont indiqués ci-dessous.

☒ Coloured covers/
Couverture de couleur

☐ Coloured pages/
Pages de couleur

☐ Covers damaged/
Couverture endommagée

☐ Pages damaged/
Pages endommagées

☐ Covers restored and/or laminated/
Couverture restaurée et/ou pelliculée

☐ Pages restored and/or laminated/
Pages restaurées et/ou pelliculées

☐ Cover title missing/
Le titre de couverture manque

☒ Pages discoloured, stained or foxed/
Pages décolorées, tachetées ou piquées

☐ Coloured maps/
Cartes géographiques en couleur

☐ Pages detached/
Pages détachées

☐ Coloured ink (i.e. other than blue or black)/
Encre de couleur (i.e. autre que bleue ou noire)

☒ Showthrough/
Transparences

☐ Coloured plates and/or illustrations/
Planches et/ou illustrations en couleur

☒ Quality of print varies/
Qualité inégale de l'impression

☐ Bound with other material/
Relié avec d'autres documents

☐ Continuous pagination/
Pagination continue

☐ Tight binding may cause shadows or distortion along interior margin/
La reliure serrée peut causer de l'ombre ou de la distorsion le long de la marge intérieure

☐ Includes index(es)/
Comprend un (des) index

☐ Blank leaves added during restoration may appear within the text. Whenever possible, these have been omitted from filming/
Il se peut que certaines pages blanches ajoutées lors d'une restauration apparaissent dans le texte, mais, lorsque cela était possible, ces pages n'ont pas été filmées.

Title on header taken from: /
Le titre de l'en-tête provient:

☐ Title page of issue/
Page de titre de la livraison

☐ Caption of issue/
Titre de départ de la livraison

☐ Masthead/
Générique (périodiques) de la livraison

☐ Additional comments: /
Commentaires supplémentaires:

This item is filmed at the reduction ratio checked below/
Ce document est filmé au taux de réduction indiqué ci-dessous.

10X	14X	18X	22X	26X	30X
☐	☐	☒	☐	☐	☐
12X	16X	20X	24X	28X	32X

The copy filmed here has been reproduced thanks to the generosity of:

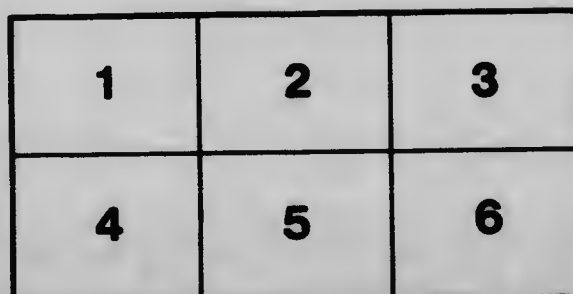
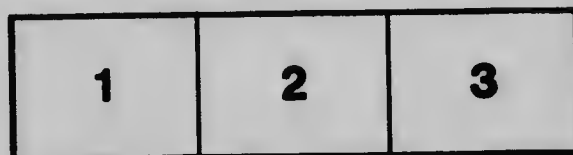
National Library of Canada

The images appearing here are the best quality possible considering the condition and legibility of the original copy and in keeping with the filming contract specifications.

Original copies in printed paper covers are filmed beginning with the front cover and ending on the last page with a printed or illustrated impression, or the back cover when appropriate. All other original copies are filmed beginning on the first page with a printed or illustrated impression, and ending on the last page with a printed or illustrated impression.

The last recorded frame on each microfiche shall contain the symbol $\rightarrow$ (meaning "CONTINUED"), or the symbol ∇ (meaning "END"), whichever applies.

Maps, plates, charts, etc., may be filmed at different reduction ratios. Those too large to be entirely included in one exposure are filmed beginning in the upper left hand corner, left to right and top to bottom, as many frames as required. The following diagrams illustrate the method:



L'exemplaire filmé fut reproduit grâce à la générosité de:

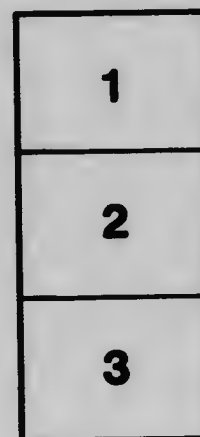
Bibliothèque nationale du Canada

Les images suivantes ont été reproduites avec le plus grand soin, compte tenu de la condition et de la netteté de l'exemplaire filmé, et en conformité avec les conditions du contrat de filmage.

Les exemplaires originaux dont la couverture en papier est imprimée sont filmés en commençant par le premier plat et en terminant soit par la dernière page qui comporte une empreinte d'impression ou d'illustration, soit par le second plat, selon le cas. Tous les autres exemplaires originaux sont filmés en commençant par la première page qui comporte une empreinte d'impression ou d'illustration et en terminant par la dernière page qui comporte une telle empreinte.

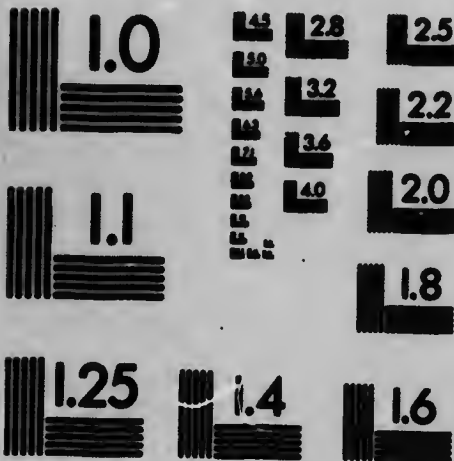
Un des symboles suivants apparaître sur la dernière image de chaque microfiche, selon le cas: le symbole $\rightarrow$ signifie "A SUIVRE", le symbole ∇ signifie "FIN".

Les cartes, planches, tableaux, etc., pouvant être filmés à des taux de réduction différents. Lorsque le document est trop grand pour être reproduit en un seul cliché, il est filmé à partir de l'angle supérieur gauche, de gauche à droite, et de haut en bas, en prenant le nombre d'images nécessaire. Les diagrammes suivants illustrent la méthode.



MICROCOPY RESOLUTION TEST CHART

(ANSI and ISO TEST CHART No. 2)



APPLIED IMAGE Inc

1653 East Main Street
Rochester, New York 14609 USA
(716) 482-0300 - Phone
(716) 288-5889 - Fax

101



SUPPLEMENTARY EXERCISES

IN

ARITHMETIC

BY

ALFRED T. DELURY, M.A.,

ASSOCIATE PROFESSOR OF MATHEMATICS, UNIVERSITY OF TORONTO.

TORONTO :

CANADA PUBLISHING COMPANY (LIMITED).

QA106

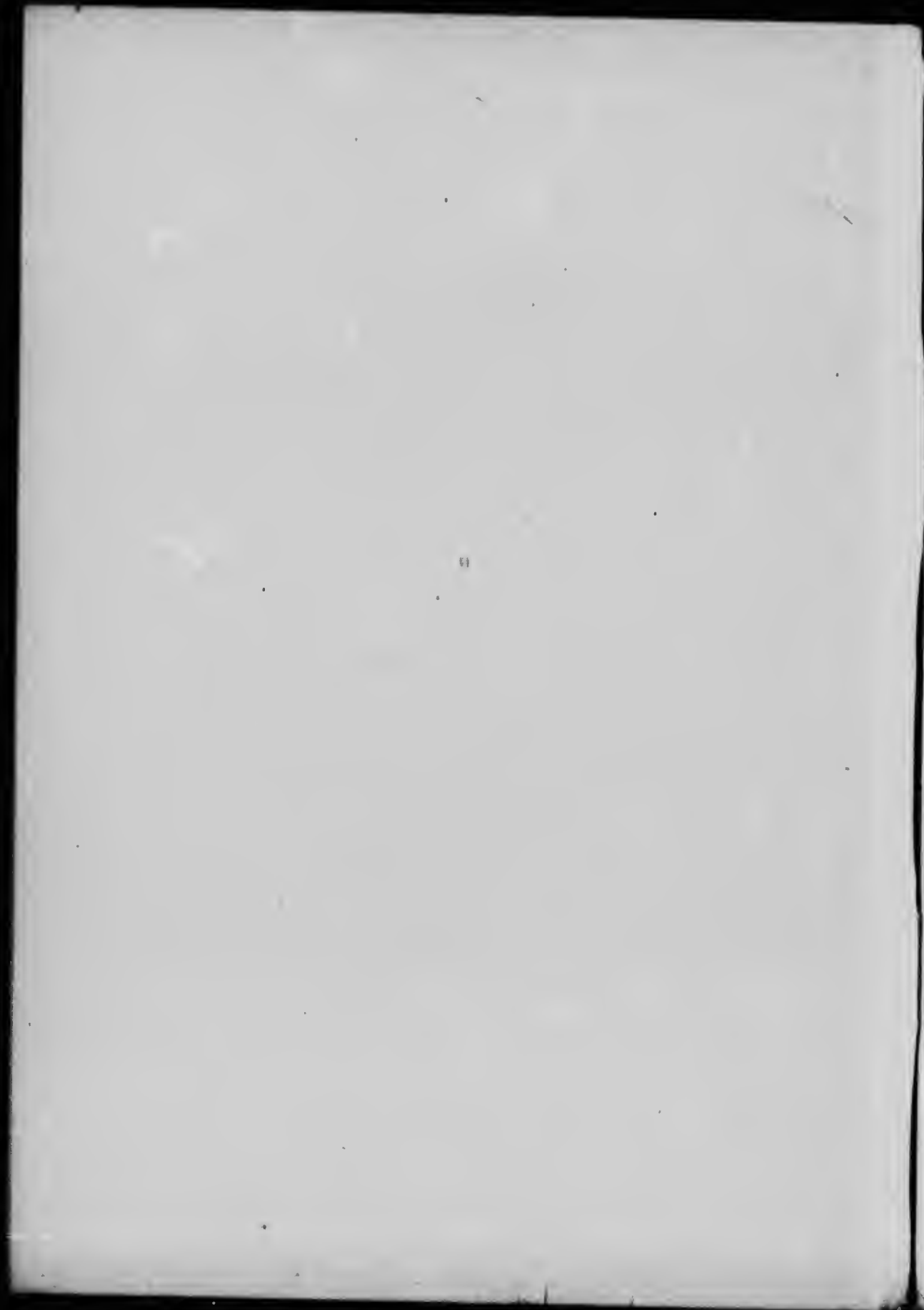
D4

Entered according to Act of Parliament of Canada, in the office of the Minister
of Agriculture by the CANADA PUBLISHING COMPANY (Limited), in the year
One Thousand Nine Hundred and Five.

PREFACE

In the preface to the re-issue of the Arithmetic for High Schools, mention was made of the intention to issue from time to time sets of graded problems in order to afford freshness and variety in the matter of exercises and at the same time to furnish additional work for those schools in which it is found advisable to give special attention to the important subject of arithmetic. This is the first of these sets.

The exercises are given under headings corresponding, except as to order, to the division into sections of Part II., of the Arithmetic, an addition, however, being made of a few exercises bearing on Physics and Chemistry. Under each heading the exercises appearing towards the end are specially designed for students preparing for the teachers' examination. It is recommended that logarithms be employed wherever computation may be facilitated by their use. The introductory notes, though dealing with nothing new, may be found to be not without interest.



INTRODUCTION

1. The Unitary Method: Proportion. In the solution of an extensive class of problems in arithmetic the unitary method or the method of analysis is so exclusively followed that the terms descriptive of the method are now seldom met with. The adoption of this method implied the passing of the ancient Rule of Three. The superiority of the unitary method for purposes of explanation cannot for a moment be questioned. The Rule of Three is obviously a rule, and the application of it tends soon to become mechanical; in a solution by the unitary method each statement is practically axiomatic. In each method, however, the essential idea is the same, namely, that of proportion, the one unduly emphasizing it, the other, unduly perhaps, keeping it in the background. While in no sense is a return to the Rule of Three advocated, it is believed that it would be well to develop the unitary method along the line of a more direct and explicit recognition of the idea of proportion.

A few examples are given in way of illustration :

A. Problem : If 17 acres of land cost \$595, find the cost of 45 acres at the same price an acre.

The ordinary solution by the unitary method should in time be made to lead to a direct comparison of 45 acres with 17 acres, so that the student will see at once that as 45 acres are $\frac{15}{17}$ of 17 acres, the cost of 45 acres will be $\frac{15}{17}$ of the cost of 17 acres. His solution will then be:

47 a. cost \$595

$\therefore$ 45 a. cost $\frac{15}{17}$ of \$595, or \$1575

This solution by direct comparison does not differ in essence from that ordinarily given by young pupils : it implies merely the adoption of a different unit. Yet in this direct comparison there is an actual

economy, which as the student advances is of real moment, the economy being not merely of statement but of thought.

B. Problem: If 5 men can do a piece of work in 21 days, how long would it take 7 men to do the work?

The ordinary solution should be made to lead the student to see that as 7 men are $\frac{7}{5}$ of 5 men—from the point of view of the work in question—then the time required to do the work by 7 men is $\frac{5}{7}$ of the time required by 5 men. The solution might then be written thus:

5 men can do the work in 21 days

$\therefore$ 7 men can do the work in $\frac{5}{7}$ of 21 days or 15 days.

Thus as in A it was seen that the cost of the land was proportional to the amount, so here the time required is inversely proportional to the number of men.

C. Problem: The change in volume of a gas contained in a cylinder with a close-fitting piston is inversely proportional to the pressure of the piston; if when the pressure of the piston is 200 pounds the volume of the gas is 72 cubic feet, find the volume when the pressure is 360 pounds.

At once:

The volume required is $\frac{200}{360}$ of 72 cubic feet, or 40 cubic feet.

D. Problem: A and B together received \$4.60 for a day's work; A's rate of work is to B's as 2 to 3, and A works only 4 hours to B's 5 hours. How should the money be divided?

If A and B worked the same time, A's share would be equal $\frac{2}{5}$ of B's share.

But as A worked only 4 hours to B's 5 hours, his share, relative to B's, should be only $\frac{4}{5}$ of what it would be if A and B worked the same time.

$$\therefore \text{A's share} = \frac{4}{5} \text{ of } \frac{2}{5} \text{ of B's share.}$$

$$= \frac{8}{25} \text{ of B's share.}$$

$$\therefore \text{A's share} = \frac{8}{25} \text{ of } \$4.60 = \$1.60.$$

$$\text{And B's share} = \frac{17}{25} \text{ of } \$4.60 = \$3.00.$$

2. On Algebraical Solutions. A great many problems proposed as exercises in arithmetic admit more readily solutions by algebra, so that there arises the question of the relative values of the two solutions. While it is often difficult to say of a solution that it is

algebraical rather than arithmetical there is, in general, a real distinction. In the arithmetical treatment the worker is kept constantly in close contact with the facts of the problem; in the algebraic treatment the facts and conditions are translated into relations between given and unknown numbers, and operations—almost mechanical—elicit from these relations the number or numbers sought. Insisting thus on a sharp realization of the actual circumstances of the problem, in other words, requiring the student to think more concretely, the arithmetical solution is as a rule the more educative, though it is easy to be too critical in the matter of excluding algebra. When, then, an algebraical solution obtrudes itself, it is well to obtain the arithmetical solution also, supposing it to be not too difficult to be grasped by the student; the comparison of the two solutions is likely to be helpful in both subjects.

As an example consider the following problem:

Two cisterns of the same dimensions are filled with water. The pumps of the cisterns can empty them in 48 and 60 minutes respectively; if the pumps are set in action at the same instant, at the end of what time will the depth of water in the second be twice that of the water in the first?

(1) *Algebraical Solution:*

Let h measure the depth of each cistern;

Let x be the number of minutes required.

$\therefore \frac{x}{48} h$ and $\frac{x}{60} h$ measure the depth of water removed.

$$\therefore \left(h - \frac{x}{48} h \right) \times 2 = \left(h - \frac{x}{60} h \right).$$

$$\therefore 2 - \frac{1}{24} x = 1 - \frac{1}{60} x$$

$$\therefore \left(\frac{1}{24} - \frac{1}{60} \right) x = 1$$

$$\therefore x = 40$$

Thus time required is 40 minutes.

(2) Arithmetical Solution:

Suppose that there is a third cistern with a pump which will remove in any time as much more water than the first, as the first withdraws more than the second.

Now the two pumps remove $\frac{1}{48}$ and $\frac{1}{96}$ of the depth of water in 1 minute.

Therefore the third pump will remove $\left\{\frac{1}{48} + \left(\frac{1}{48} - \frac{1}{96}\right)\right\}$ of the depth in 1 minute, i.e. $\frac{1}{32}$ of its depth in 1 minute.

The third pump will therefore empty its cistern in 40 minutes.

Let now all pumps be set in action. It is plain that, when the third has emptied its cistern, the water in the second is of twice the depth of that in the first. This happens in 40 minutes, so that this is the time required.

MISCELLANEOUS EXAMPLES

I

1. Find the number which, divided into 73,840 and 93,590, will give as remainders 127 and 153.
2. How much water must be added to a mixture of 15 gallons of vinegar, costing 52 cents a gallon, and 13 gallons costing 40 cents a gallon that \$5 may be gained by selling the whole at 15 cents a quart?
3. A cistern has three supply pipes—A, B, C. By B and C together it can be filled in 3 hours, by C and A together in 4 hours, and by A and B together in 5 hours: in what time could it be filled by each pipe and by all?
4. A merchant bought cloth at \$1.50 a yard, and sold it to gain \$300. Had his gain per cent. been $8\frac{1}{2}$ per cent. less, he would have gained \$225. Find the number of yards.
5. Three persons, A, B, C, each having \$150 go to see the World's Fair, agreeing to share all expenses equally. On their return A has \$40.25, B has \$59.50 and C has \$53.70. What should be done to adjust the expenses?

II

1. (a) Find the G. C. M. of:
 $\frac{6}{7}, \frac{9}{10}, \frac{11}{12}.$
(b) Find the L. C. M. of:
 $\frac{1}{2}, \frac{2}{3}, \frac{3}{4}.$
2. On a map, one inch represents 4 miles; how many acres would be represented by a rectangle 1.43 inches by 1.24 inches?
3. A drover bought a number of cattle for \$4375, and sold a certain number of them at \$43 each, for the total sum of \$3655, gaining \$680; at how much each must he sell the rest so as to gain \$400 more?
4. A man bought two lots for \$1600. He sold the cheaper at an advance of 20 per cent., and the dearer at an advance of 15 per cent., gaining on the whole \$275. Find the cost of each lot.
5. How much crude ore must be taken from a mine, so that after a loss of 30 per cent. in roasting, and 40 per cent. of the remainder in smelting, there may be 400 tons of pure metal?

III

1. Find by the contracted method, correctly to three decimal places, the products:

(a) 1.3725×3.0579 ;

(b) $1.2937 \times 0.3754 \times 2.0374$.

2. A man has 1 hr. 20 min. to make the journey from Sunnyside to the Rifle Ranges, a distance of 12 miles. How far will he take the electric car, which travels at the rate of 15 miles an hour, so that walking the rest of the way, at the rate of 4 miles an hour, he may reach the ranges in time?

3. A dealer gave \$18,000 for a certain number of horses, and he sold a certain number of them for \$7750, at \$155 each, thereby gaining \$5 each; for how much each must he sell the rest in order to gain \$2000 on the whole?

4. The demand of 10 hours' pay for 9 hours' work is equivalent to a demand of what increase per cent. in wages?

5. A grocer buys tea at 20 cents and at 30 cents a pound and mixes them in the ratio of 9 to 4. At what price must the mixture be sold to yield a gain of 30 per cent.?

IV

1. Find by the contracted method, correctly to three decimal places, the quotients:

(a) $1.54273 \div 2.3784$;

(b) $1 \div 2.5937$.

2. A messenger has to make 5 miles in 45 minutes. He can walk at the rate of 4 miles an hour or run at the rate of 8 miles an hour. How far will he have to run?

3. Between 1871 and 1881 the county of A lost 24.73 per cent. of its population by deaths and removals, but during the same time it gained 42.41 per cent. by births, etc., the percentages being reckoned on the population in 1871. In 1881 the population was found to be 26,478. What was it in 1871?

4. A train travels $\frac{1}{3}$ of the distance between two towns at the rate of 24 miles an hour, $\frac{1}{3}$ of the distance at 30 miles an hour, and the rest at 36 miles an hour. Find the average rate.

5. Three persons, A, B, C, start on a trip agreeing to share all expenses equally. A has \$351, B has \$400, and C has \$500. On their return A has \$105.50, B has \$125.50, and C has \$198.00. What should be done to adjust the expenses?

V

1. Find the value, correct to three decimal places, of:

$$\frac{3.217 \times 7.325}{1.219 \times 3.769}$$

2. A and B start together in the same direction round a circular track, A walking 9 yards in the same time that B walks 7 yards. At what point of the track will A first overtake B?

3. Two equal glasses are filled with a mixture of spirits and water; in the first the proportion is 3:1 and in the second 4:1. The contents of the two glasses are poured into a single vessel; find the strength of the mixture.

4. A man bought goods and sold them at an advance of 20 per cent. If the goods had cost \$20 less and had sold as in the actual case the gain would have been 35 per cent. Find the cost of the goods.

5. A grocer mixes coffee costing 25 cents a pound, with chicory costing 6 cents a pound, in such a proportion that by selling the mixture at 29 cents a pound he gains 50 per cent. on the chicory and 32 per cent. on the coffee. Find the proportion.

VI

1. Find, correctly to two places of decimals, the square roots of:

513, 627, 1853.

2. If telegraph posts are placed 80 yards apart, and a train passes one every 4 seconds, find at what rate, in miles an hour, the train is going.

3. For doing a certain piece of work \$24 is to be paid. A could do it in 8 days and B in 10 days; the work is done in 3 days by A, B, C working together. Find each man's share.

4. In a mile race A wins, beating B by 22 yards, and C, by 33 yards: by how many yards does B beat C?

5. A man, having bought a lot of goods for \$750, sells one-third at a loss of 4 per cent.; by what increase per cent. must he raise that selling price in order that by selling the rest at the increased rate he may gain 4 per cent. on the whole transaction?

VII

1. Find, correctly to three places of decimals, the square roots of :

$$\frac{5}{7}, \frac{11}{12}, \frac{111}{112};$$

- (1) after changing the fractions into equivalent fractions with denominators a perfect square;
 (2) after expressing the fractions as decimals.

2. At an election the successful candidate received $\frac{1}{4}$ of the total number of votes cast, and had a majority of 832 over his rival. Of the total number of electors in the constituency $\frac{1}{5}$ did not vote. How many electors were there in the constituency?

3. A man bought pencils at the rate of 5 for 2 cents, and sold half of them at 3 for a cent, and a half at 2 for a cent, gaining 66 cents. How many pencils did he buy?

4. Leap year is omitted in those years, the numbers expressing which end in two zeros, except when the number of hundreds is divisible by 4. Find the average length of the year to 4 places of decimals.

5. A man mixes 28 lbs. of black tea with 36 lbs. of an inferior quality, which costs 20 cents a pound less, and by selling the mixture at 58 $\frac{1}{2}$ cents a pound, gained 20 per cent. Find the cost of each kind of tea.

VIII

1. Find, correctly to three decimal places, the sum :

$$\frac{1}{12} + \frac{11}{12} + \frac{11}{12}$$

- (1) after adding as vulgar fractions;
 (2) after expressing each fraction as a decimal.

2. At what advance on cost must a merchant mark his goods in order that he may make a profit of 14 per cent. after allowing a discount of 5 per cent. on the marked price?

3. Two vessels, each holding 10 quarts, are filled, the one with wine and the other with water. One-tenth is withdrawn from each and placed in the other; then one-tenth is withdrawn from each and placed in the other, and again this is done. Find the strength of the mixture in each vessel now.

4. In a mile race between a bicycle and a tricycle their rates were as 5 to 4; the latter had half a minute's start and was beaten by 176 yards. Find the actual rate of each.

5. On a quantity of tea a grocer fixed a price to make a gain of 25 per cent., but $\frac{1}{4}$ of the quantity was found to have been damaged, and he had to reduce the price on this 25 cents a pound, and so his whole gain was $48\frac{1}{2}$ per cent. less than the sum he had expected to gain. What price did he pay for the tea?

IX

1. Find, correctly to two decimal places, the value of the product:

$$\sqrt{11} \times \sqrt{37};$$

- (1) after finding each square root to a sufficient number of places;
- (2) by regarding $\sqrt{11} \times \sqrt{37}$ as equal to $\sqrt{11 \times 37}$.

2. A bankrupt had goods worth \$7950, which, if sold at their full value, would give his creditors $81\frac{1}{2}$ per cent. of their claims. But $\frac{1}{4}$ of them were sold at $17\frac{1}{2}$ per cent. below their value, and the remainder at $23\frac{1}{2}$ per cent. below their value. How many cents on the dollar did his creditors realize?

3. A can do work in 10 days, B in 9 days, C in 12 days; all begin together, but A leaves in $3\frac{1}{2}$ days before the completion, B in $2\frac{1}{2}$ before the completion. In what time is the work done?

4. A man bought goods and sold them at an advance of 20 per cent. Had the goods cost \$10 less and sold for \$16 more there would have been a gain of 28 per cent. Find the cost of the goods.

5. A grocer intended to gain 8 per cent. on a stock of tea, and fixed his price accordingly; after selling $\frac{1}{4}$ of his stock he had to reduce the price 10 cents a pound, and as a result gained only half as much as he had intended. Find the original cost a pound of the tea.

X

1. Find, to three decimal places, the value of:

$$\frac{17}{29} \times \frac{123}{168} \times \frac{2.59}{3.73}$$

- (1) after finding the product of the vulgar fractions;
- (2) after expressing each fraction as a decimal.

2. Two men, A and B, enter into business; A is to receive \$25 a month and 10 per cent. of the sales for managing the business, the remaining profits to be divided equally. The goods are sold at an average profit of 30 per cent. Find the total sales, in order that B may receive 24 per cent. of the profits.

3. A and B can do a work in 12 days, B and C in 18 days, A and C in 30 days; all work together for 5 days and then A leaves; the other two go on for 6 days and then B leaves. In how many days will C finish the work?

4. A merchant sells 9 pounds of tea for a certain sum, gaining $33\frac{1}{3}$ per cent.; he changes the price, selling 8 pounds for the same sum. Find his gain per cent. at the new price.

5. In building a house I paid $2\frac{1}{2}$ times as much for material as for labour; had the latter cost 8 per cent. more, and the former 10 per cent. more, the whole cost would have been \$2872.50. Find the actual cost.

XI

1. Find, correctly to four places of decimals, the value of:

$$(0.2684)^2 + (0.9633)^2.$$

2. A and B enter into partnership for 3 years. A puts in \$20,000 and B \$5000; B is to manage the business, and the profits are to be equally divided; but at the end of the first year A increases his stock to \$36,000. How shall they divide a gain of \$28,500 at the end of the three years?

3. A train leaves Toronto for Hamilton at 5.55 p.m., running at the rate of 26 miles an hour. Another leaves Hamilton for Toronto at 6.35 p.m., running 40 miles an hour. Before they meet the first loses 5 minutes and the second 10 minutes by stoppages. At what time will the trains meet, Toronto and Hamilton being 39 miles apart?

4. A man invests $\frac{1}{3}$ of his capital at 5 per cent., $\frac{1}{3}$ of his capital at $4\frac{1}{2}$ per cent., and the rest of his capital at 4 per cent. If his total income is \$535, find his capital and the average rate.

5. A contractor engaged to complete 1000 yards of railway in 50 days, and employed 100 men working 9 hours a day; but at the end of 30 days he found only 450 yards finished. How many additional men must he hire in order that all working 10 hours a day may finish the work in the given time?

XII

1. Find, to two places of decimals, the cube roots of:

$$73, 1374, 15.37.$$

2. The hour, minute and second hands of a clock are on concentric axes. When first after 12 o'clock will the second hand be midway between the hour and minute hands?

3. A number of men and women earned \$93 a day, each man getting \$2.25 and each woman \$1.50. Had there been 6 more men and 7 more women the whole number of women would have earned the same as the whole number of men. Find the actual number of each.

4. A can do a piece of work in 12 hours, B in 15 hours, and C in 18 hours. They work together, C leaving one hour and B two hours before the work is finished: find how long each worked, and if \$5 were paid for the work, find the share of each.

5. A merchant buys goods and sells $\frac{1}{2}$ of them at an advance of 20 per cent. At what advance on this selling price must he sell the rest in order to gain 30 per cent. on the whole?

XIII

1. Find, to three places of decimals, the cube roots of:

$$\sqrt[3]{1}, \sqrt[3]{\frac{1}{7}}, \sqrt[3]{\frac{1}{8}}$$

(1) after expressing the fractions as equivalent fractions with their denominators cubes;

(2) after expressing the fractions as decimals.

2. Two trains, 77 yds. and 55 yds. long, moving in opposite directions on parallel rails, pass each other in 5 seconds, but when they are moving in the same direction the faster passes the slower in 45 seconds. Find the rate of each train.

3. Three kinds of tea are mixed in the proportion 4:5:6. When 10 lb. of the first kind and 15 lb. of the second kind are added, the third kind is 30 per cent. of the mixture; find the number of pounds of each kind in the original mixture.

4. In a certain farm the amount of cleared land is to that not cleared as 11 to 5. After 10 acres more are cleared the proportion is 3 to 1. Find the number of acres in the farm.

5. A contractor engages to have a piece of work finished in 36 days, and employs 50 men, who work 8 hours a day. At the end of 24 days only $\frac{1}{3}$ of the work is done: how many men must be taken on, in order that, all working 9 hours a day, the work may be finished in time?

XIV

1. Find, to two decimal places, the value of $\sqrt[3]{5} \times \sqrt[3]{11}$

(1) after finding each cube root to a sufficient number of places;

(2) by regarding $\sqrt[3]{5} \times \sqrt[3]{11}$ as equivalent to $\sqrt[3]{5 \times 11}$.

2. Two trains, T_1 and T_2 , can make the journey from P to Q in 60 and 90 hours respectively. T_1 leaves P and T_2 leaves Q at the same time; when and where will they meet, and in what times after meeting will they complete the journey?

3. Nine coins of equal weight, made of gold and silver, are melted together and recast. In two of them the gold and silver are in the ratio of 3 to 1, in three others in the ratio of 3 to 2, and in the rest in the ratio of 4 to 3; what will be the ratio of gold and silver in the new coins?

4. A man is to row over a certain course in a certain time. By rowing at the rate of four miles an hour he would arrive 5 minutes too late; and by rowing at the rate of five miles an hour he would arrive 10 minutes too early. Find the length of the course and the time of rowing.

5. A compound of tin and lead weighs 10.43 times as much as an equal bulk of water, while tin weighs 7.44 times, and lead 11.25 times as much as equal bulks of water. Find the number of pounds of each metal in 765 lbs. of the compound.

XV

1. Find, to two decimal places, the sixth roots of:
7, 29, $\frac{1}{2}$.

2. A bicyclist has to make a certain distance in a certain time. If he rides at the rate of 15 miles an hour he will be 5 minutes early, and if at the rate of 10 miles an hour he will be 5 minutes late. Find the distance, the time, and the rate at which he should ride.

3. A and B are to race from M to N and back; A moves at the rate of 10 miles an hour, and gets a start of 20 minutes. On A's returning from N he meets B moving towards it, and one mile from it; but A is overtaken by B when one mile from M. Find the distance from M to N.

4. A retail merchant bought a quantity of tweed and marked it at an advance of 25 per cent., and in selling it used a yard measure $\frac{1}{2}$ of an inch too short; if his whole gain is \$124.80 find the cost price of the cloth and the amount the merchant gained by using the false measure.

5. At what advance on cost must a merchant mark his goods so that after allowing 6 per cent. of his sales for bad debts, 7 per cent. of the cost for expenses, and an average credit of 6 months (money being worth 6 per cent.), he may make a clear gain of 15 per cent. on the first cost of the goods?

XVI

1. Which of the following statements:

$$\frac{10}{5.000} = 1.11; \frac{10}{1.11} = 9.000,$$

is the more nearly correct?

2. A railway train leaves a station at 2 o'clock. One hour later a second train leaves the same station and overtakes the former at 7 o'clock. Had the rate of the second train been 1 mile an hour less it would have overtaken the first train at 8 o'clock. Find the rates of the trains.

3. A growing crop of grass would last 12 cattle 10 days or 18 cattle 6 days. How long would it last 13 cattle?

4. \$1200 is to be distributed among A, B and C. From part of it they receive equal amounts, and of the rest B's share is 10 per cent. more than A's share, and C's is 10 per cent. more than B's. Altogether B's share is $8\frac{1}{3}$ per cent. more than A's, and $7\frac{1}{3}$ per cent. less than C's. Find the part of the \$1200 that was divided equally.

5. A and B start together in a mile race, A at the rate of 320 yards a minute and B at the rate of 380 yards a minute. At what time will B be midway between A and the winning post?

XVII

1. Shew that the difference between two numbers having the same digits is divisible by 9 whatever be the order of the digits in the second number.

2. A merchant buys a quantity of cloth for \$525; by marking the cloth at an advance of 20 per cent. and employing a false measure he gains \$123; find the length of the false yard measure.

3. A messenger has to reach a certain point at a certain time. He can walk at the rate of 132 yards a minute or can run at the rate of 220 yards a minute. If he should walk the whole way he would be 2 minutes late, and if he should run the whole way he would be 4 minutes early. Find the distance, the available time, and how far he must run.

4. A watch loses 45 seconds a day. If it is right on Monday at 3 o'clock, what time does it indicate at 3 o'clock on the following Monday?

5. A reduction of 20 per cent. in the price of coffee would enable a purchaser to buy 5 pounds more for \$6; find the price of coffee.

XVIII

1. Define average and shew that the average of several unequal numbers is less than the greatest and greater than the least.

Hence shew that the fraction $\frac{s+t}{s+t}$ is intermediate in value to the fractions $\frac{s}{s+t}$ and $\frac{t}{s+t}$.

2. Two vessels each holding 12 gallons are filled, one with wine and water in the ratio of 2:1 and the other with wine and water in a certain ratio. One-fourth of the mixture in each is withdrawn and placed in the other, and the ratio of wine and water in the first vessel is 17:7. Find the original and final ratios of wine and water in the second vessel.

3. The diameter of the hind wheel of a carriage exceeds that of the fore wheel by 14 inches, and the fore wheel makes 120 revolutions more than the hind wheel in going one mile; find the radii of the wheels.

Give and compare the arithmetical and algebraical solutions.

4. A train leaves a station at 1 o'clock, and one hour later a second train leaves the same station and overtakes the first train at 6 o'clock. Had the first train been 5 miles farther on the road when the second started it would have been overtaken at 7 o'clock. Find the rates of the trains.

5. Three vessels, A, B, C, hold 3, 4, 5 quarts. A is empty, B is full of wine, and C is full of water. The following operation is performed twice: A is filled from C, then C is filled from B, and then A is emptied into B; find the strength of the mixtures in B and C at the end.

XIX

1. Employ the relation

$$(n+1)^2 - n^2 = 2n + 1$$

to solve the following:

- (1) The difference between the squares of two consecutive integers is 723; find the integers.
- (2) The square of 4937 is 24,373,969; find the square of 4936 and of 4938.

2. A merchant bought 3685 yds. of cloth and marked it at an advance of $33\frac{1}{2}$ per cent. on cost; in selling the first half of it he gave only 35 inches for a yard, but in selling the remainder he gave 37 inches for a yard. He gained on the whole transaction \$3897. What did the cloth cost him per yard?

3. A growing crop of grass would last 18 cattle 15 days or 25 cattle 10 days. How long would it last 19 cattle?

4. At what time between 5 and 6 o'clock is the minute hand of a watch midway between the hour hand and the mark on the dial bearing the figure seven?

5. A train 110 yards long overtakes A, who is going at the rate of 4 miles an hour, and passes him in 9 seconds. Ten minutes after leaving A the train meets B, and passes him in $7\frac{1}{2}$ seconds. In what time after meeting the train will B meet A?

XX

1. Explain the significance of the sign of equality in the relation

$$\frac{1}{3} = 0.3333 \dots \text{in infinitum.}$$

2. Two trains start at the same instant, the one from P to Q the other from Q to P. After meeting, it takes them 9 hours and 16 hours respectively to complete their run. Compare their rates and find how long it takes each to make the complete run.

If the distance from P to Q is 504 miles find the rates.

3. If 20 acres of a certain meadow in which the growth is uniform affords pasture for 133 oxen for 13 days, and 5 acres of it afford pasture for 25 oxen for 18 days, for how many days will 4 acres of it afford pasture for 25 oxen?

4. Two vessels, each holding twelve gallons, are filled, one with wine and water in the ratio of 3 : 1, and the other with wine and water in a certain ratio. One-third of the mixture in each is withdrawn and placed in the other, and then one-fourth of the mixture in each is withdrawn and placed in the other. The ratio of wine and water in the first vessel is now 31 : 17; find the original and final ratios of wine and water in the second vessel.

5. A leaves P for Q, 39 miles distant, at the same time that B leaves Q for P; they travel at uniform rates till they meet. B then increases his speed one-eighth, and reaches P in 5 hours from the time he met A; while A, after resting for an hour, proceeds at $\frac{5}{8}$ of his former rate and reaches Q at the same time that B reaches P. Find the rate at which each set out.

COMMERCIAL ARITHMETIC

I

1. Find the interest on \$843.50 for 93 days at the rate of $4\frac{1}{2}$ per cent.
2. A note for \$500, bearing interest at $4\frac{1}{2}$ per cent., is made on April 7, 1905, at 90 days. It is discounted May 1 at the rate of 5 per cent.; find the proceeds.
3. A merchant who can keep his money invested at 5 per cent. marks his goods at three prices, one for cash, one at three months, and one at six months. Find the cash price and the six months' price of an article of which the three months' price is \$7.50.
4. A dealer in the town of X, Ontario, buys books to the value of \$43.75 from a bookseller in Toronto. In what different ways may he remit for this amount?
Which of these ways are available in an ordinary small village?
(The student should, by actual enquiry or otherwise, find the charge connected with the remittance for each way.)
5. A man invested \$6000 in 3 per cent. stock at 75, and \$7200 in another stock at 90. If his income from the latter exceeded that from the former by \$80, find the rate paid by the latter stock.

II

1. The interest on \$460 for 53 days is \$3.01; find the rate per cent.
2. Owing a man \$320, I give him a sixty-day note; find the face of the note if, when discounted at 6 per cent., it meets the obligation.
3. The rent of a house is \$25 a month, paid at the end of each quarter. Find the equivalent yearly rental paid in advance, money being worth $4\frac{1}{2}$ per cent.
4. A man buys a house and lot for \$4000. He insures the house for \$3600 at the rate of $\frac{1}{2}$ per cent.; the house is burnt, and he sells the lot for \$800. Find his gain and the loss of the insurance company.
5. A merchant wishes to send his agent a sum of money sufficient to buy 5000 yards of cloth at \$1.35, and to pay his commission at 3 per cent.; find the sum he should remit.

III

1. The interest on \$610 for a certain time at 5 per cent. is \$7.77; find the time.
2. A man wishing \$800 ready money, borrows it from a bank, giving his note at 90 days. If the rate of discount is 5 per cent., find the face of the note.
3. A grain merchant bought 12,000 bushels of wheat at 92 cents a bushel, to be paid at the end of six months: he sold it at once at 91 cents a bushel, and deposited the proceeds at 4 per cent. per annum. At the end of six months he paid for the wheat; find the balance to his credit on the transaction.
4. A merchant ships a cargo which cost him \$12,000. He insures it so that in case of loss he will recover the value of the cargo, \$400 paid for freight, and the premium; if the rate is $\frac{1}{2}$ per cent., find the premium.
5. A 6 per cent. stock is quoted at 129, and an 8 per cent. stock at 171; brokerage being $\frac{1}{2}$ per cent., find which affords the better investment.

IV

1. A certain sum of money amounts in 54 days, at 5 per cent., to \$181.33; find the sum.
2. A man bought a lot for \$540, and sold it at once, receiving a 60-day note for \$625, which he discounts at the rate of 5 per cent.; find his gain per cent. on the transaction.
3. A man is offered for a house \$5000 cash, or \$5250 at the end of one year; find the immediate gain through accepting the better offer, money being worth $4\frac{1}{2}$ per cent.
4. A merchant in Toronto buys goods to the value of \$93.75 from a merchant in New York. In what different ways may he remit for this amount?
5. A man divides \$1300 into two sums, and lends them at different rates of interest. He finds the incomes from them to be equal. If he had lent the first at the rate of the second he would have received \$36, and the second at the rate of the first he would have obtained \$49; find the rates of interest, and the sums.

V

1. A savings bank allows 3 per cent. per annum on deposits, the interest for any month being calculated on the minimum balance for that month, and the books being closed on June 30 and December 31. At the beginning of the year a depositor had \$437.54 to his credit; the deposits during the year were as follows:

Jan. 17, \$40; March 4, \$57; April 13, \$57.60;

June 11, \$29.50; Aug. 29, \$25; Nov. 17, \$97.40;

and the withdrawals as follows:

Feb. 11, \$28.50; May 15, \$60; July 12, \$15;

Dec. 15, \$64.50.

What sum will be standing to the depositor's credit at the beginning of the new year?

2. A note for \$600, bearing interest at 5 per cent., is made on Jan. 11, 1905, at 90 days. On Feb. 12 it is discounted at the rate of 6 per cent.; find the proceeds and the rate per annum made by the banker on the money advanced.

3. A person borrows \$400, agreeing to pay it back in yearly payments of \$100 each, together with the interest at the rate of 5 per cent.; it is further agreed that, if more than \$100 be paid annually on account of principal, interest will be allowed by the lender on the excess at the rate of 4 per cent. If \$150 is paid at the end of each of the first two years, what sum will cancel the debt at the end of the third year?

4. A note for \$900 made on March 5, 1902, and bearing interest at 5 per cent., has endorsed on it the following payments: May 9, 1902, \$125; Oct. 17, 1902, \$250; Dec. 20, 1902, \$375. Find the amount necessary to meet the note on March 5, 1903.

5. A merchant consigns a quantity of flour to an agent in Montreal, who charges $2\frac{1}{4}$ per cent. commission for selling and $3\frac{1}{4}$ per cent. for buying, with instructions to invest the proceeds (after deducting his commission for both transactions), in certain goods; the agent sells the flour at \$6.25 a bbl., and invests as directed, his entire commission being \$432; how many bbls. flour were consigned?

VI

1. A savings bank allows $3\frac{1}{4}$ per cent. per annum on deposits, the interest for any month being calculated on the minimum balance for that month, and the books being closed on June 30 and December 31. At the beginning of the year a depositor had \$327.50 to his credit; the deposits during the year were as follows:

Jan. 23, \$23; Feb. 15, \$39.50; May 7, \$127.30;
 July 13, \$72.60; Oct. 27, \$53.50; Dec. 11, \$13.29;
 and the withdrawals as follows:

Mar. 16, \$35.50; May 23, \$20; June 28, \$45;
 Aug. 3, \$75; Nov. 10, \$40; Dec. 20, \$90.

What sum is standing to his credit at the beginning of the new year?

2. The proceeds of a note made Mar. 15, at 90 days, for \$900, and discounted May 5, were \$894.82; find the rate of discount.

3. A man buys a house for \$5000 to be paid at the end of one year, and sells it at once for \$5400 to be paid at the end of 6 months: if money is worth 5 per cent., find his immediate gain per cent. on the transaction.

4. A merchant insured his stock at 3 per cent. for a sum sufficient to cover the value of the goods and the premium. The stock is partially destroyed and the insurance company pays but 60 per cent. of the whole claim. If the merchant receives \$6000; what was the value of his stock?

5. I invested in 7 per cent. stock at 78½, and having received a half-year's dividend I sold out at 79½, paying ½ per cent. brokerage on each transaction, and increased my capital altogether by \$292.50. How much did I invest?

VII

1. Find the interest on \$640 for 3 years 5 months at the rate of 3½ per cent.

2. A note for \$540, drawn Feb. 3, 1903, at 90 days, and discounted March 19, yielded \$535.65. Find the rate of discount.

3. A man divides \$12,000 between his two sons aged 13 and 15 years, so that, their shares being invested at 5 per cent. per annum, each will have the same amount on reaching his majority. Find the share of each.

4. A merchant in Montreal buys goods in Paris to the value of 7350 francs. In what different ways may he remit for this amount?

Which of these methods would under ordinary circumstances be employed?

If it were a question of remitting 18 francs, which of the methods would be the most likely?

5. A house that cost \$15,500 rents for \$155 a month. It is insured for \$10,850 @ ¼ per cent. yearly; the taxes are 15 mills on an assessment of \$12,450, and \$346.45 is spent each year on repairs. What rate of interest does the investment pay?

VIII

1. The difference between the simple and the compound interest for 3 years at 4 per cent. on a certain sum is \$2.12; find the sum.
2. A man buys a lot for \$800; unable to pay for it at once, he gives his note at 90 days for that sum with interest at 6 per cent. The seller of the house has the note discounted at once; how much did he lose on account of the purchaser not having ready money?
3. A is under obligation to pay B \$1000 at the end of 2 years; if money is worth $4\frac{1}{2}$ per cent., find what sum would now equitably discharge the debt.
4. A man buys a boat for \$18,000 and insures it so that in case of loss he will recover the value of the boat and one-half of the premium paid. The rate being $\frac{1}{4}$ per cent., find the premium.
5. A consignor sends 1000 bbl. of flour to a commission merchant, with instructions to sell it and remit the net proceeds by draft. The consignee pays freight and expenses, \$240.80; sells the flour at \$8.50 per barrel; charges $2\frac{1}{2}$ per cent., commission, and pays $\frac{1}{4}$ per cent., premium for draft; how much does the consignor receive?

IX

1. A man borrows \$600 to be repaid with interest at 5 per cent., compounded yearly at the end of 3 years; find what sum will then meet the debt.
Find also what rate per annum compounded half-yearly would give the same sum.
2. A man borrows \$1000 from a bank on his note at 90 days for that amount. The bank deducts the discount at 6 per cent., and the man speaks of this as *interest taken in advance*; find the rate of interest he is actually paying.
3. A merchant bought 200 yards of cloth at \$1.50 a yard payable in three months, and sold it one month after at \$1.75 a yard payable in four months. To pay the purchase money he borrowed for the necessary time at the rate of 6 per cent. Find his gain or loss on the transaction.
4. A person pays \$432 for the insurance of goods at $3\frac{1}{2}$ per cent.; he finds that if the goods are lost, he will receive from the insurance company the value of the goods, the premium of insurance, and \$40 besides. Find the value of the goods.
5. A man invests a sum of money in 5 per cent. stock at $79\frac{1}{4}$, receives a dividend, and then sells out at $82\frac{1}{4}$, brokerage in each case $\frac{1}{4}$ per cent. If his total gain is \$1200, how much did he invest?

X

1. On March 19, 1905, a man discounted a note nominally due on May 28, the rate being 4 per cent. Finding that he would not need the money, he at once deposited it in the bank which allowed him 4 per cent. interest on deposits during time of deposit. At the time when the note became legally due he found that he had 4 cents less than if he had not discounted the note. Find the amount of the note.
2. The difference between the simple and compound interest on a sum of money for 4 years at 5 per cent., is \$19.30; find the sum, and the difference between the simple and the compound interest on it at the rate for twice the time.
3. A farm is rented at \$500 a year for 3 years, the rent being due at the end of each year; what sum paid now would pay the rent for the three years?
4. A note for \$600 with interest at 5 per cent., made on May 5, 1904, has indorsed on it the following payments: June 23, \$80; Aug. 17, \$150; Oct. 13, \$120; Nov. 7, \$60.
Find what sum paid on Feb. 7, 1904, will completely pay the note.
5. A man bought a lot for \$1500. At the end of one year, having just paid a tax at the rate of 20 mills on the dollar on an assessment of \$1200, he sold the lot for a note for \$1800 at 90 days. If he could have invested his money at $4\frac{1}{2}$ per cent., and if at the time of sale he discounted the note at 6 per cent., find his net gain.

XI

1. In 4 years \$720 is found to amount to \$875.16; find the rate per cent.
2. A broker discounts a note, which will mature in 45 days, at the rate of 7 per cent.; what rate of interest does he make on the money advanced?
3. A sum of money is lent at compound interest; the interest for the third year is \$173.06, and for the fourth year is \$179.98; find the sum and the rate per cent.
4. A man bought in Toronto a bill of exchange on London for £80 at 94, and sent it to a merchant in Paris who sold it for 2025.60 francs, crediting the remitter with this amount. What rate on Paris did the remitter thus obtain?

5. A commission merchant receives a consignment of 2400 barrels of flour. He sells the flour at \$7.00 a barrel, deducts his commission at 2 per cent., pays \$137 for freight and expenses, and remits to the consignor by draft purchased at $\frac{1}{2}$ per cent., premium. Find the amount of the draft.

XII

1. A certain sum of money amounts in 3 years at 4 per cent., to \$479.44; find the sum.

2. A man thinks of buying a house which is offered for \$300 cash and \$500 at the end of each year for three years. If money is worth 4 per cent., would he do better to accept an alternative offer of the house for \$1800 to be paid at the end of two years?

3. Two sums, \$1000 each, are lent for four years, the one at 4 per cent., and the other at 5 per cent.; find the average percentage realized.

4. An insurance company issued a policy of insurance covering 80 per cent., of the estimated value of a ship and cargo at $4\frac{1}{2}$ per cent., and immediately re-insured 50 per cent., of the risk in another company at $3\frac{1}{2}$ per cent. During the voyage the ship was wrecked, and the second company lost \$900 more than the original insurer; what did the owners lose?

5. The expense of constructing a railway is \$5,000,000, of which 40 per cent., is borrowed on a mortgage at 6 per cent., and the remainder is held in shares. What must be the average weekly receipts so as to pay the shareholders 5 per cent., the working expenses being 65 per cent., of the gross receipts?

XIII

1. In a certain time \$240 lent at 4 per cent., is found to amount to \$292; employ the Interest Tables to find the time.

2. The proceeds of a note drawn March 15, 1903, at 90 days with interest at 4 per cent., discounted at a certain time at 5 per cent., were \$1021.23; find when the note was discounted.

3. The amount of a sum of money at a certain rate is \$425.43 for 4 years and \$469.03 for 6 years; find the sum and the rate.

4. The total cost of a cargo was \$7200; for what sum must it be insured so that in case of loss the consignor may recover the cost of the cargo, his expected profit of 20 per cent., on cost, and one-half of the premium?

5. A man buys 60 shares, \$50 each, Bank of Commerce stock, quoted at 161½, brokerage ½ per cent., borrowing the money from a bank on his note at 90 days, discount at 5 per cent. On the day on which he has to meet the note, having just received the half-yearly dividend of 3½ per cent., he sells at 162, brokerage ½ per cent. What balance has he on the transaction, after meeting the note?

XIV

1. In 3 years \$120 is found to amount to \$134.96; find the rate per cent.

2. A man bought a farm for \$6000, payable one-third in cash and \$1000 at the end of each year for four years. At the end of one year he sold the farm for \$8000, payable one-half in cash and the rest in one year. Find his gain at the time of selling if money was worth 5 per cent.

3. The amount of \$300 in 2 years at a certain rate is \$6.27 less than at a rate 1 per cent., higher; find the rate.

4. A Toronto merchant wishes to transmit 4000 marks to Berlin through London. Sterling exchange being at 9½, and exchange between London and Berlin being at 20.45 marks for a pound, find the cost of the bill.

5. A commission merchant sells goods for \$7500 and invests the proceeds, having deducted his two commissions at the same rate in other goods. The two commissions amount to \$194.18; find the rate.

XV

1. In a certain time, \$450 lent at 4 per cent., amounts to \$594.96; find the time.

2. A note made April 17, at 90 days for \$750 with interest at 4 per cent., was discounted May 27, at 6 per cent. Find the proceeds, and compare with the results obtained by not regarding days of grace.

3. The accumulated interest on \$400 for two years at a certain rate is \$16.64 less than at a rate 2 per cent., higher; find the rate.

4. A demand note for \$450 with interest at 4 per cent., made Aug. 5, 1904, has indorsed on it the following payments: Dec. 17, \$5; Dec. 23, \$10; Dec. 29, \$15; Jan. 15 (1905), \$50; Jan. 30, \$100; Feb. 15, \$200. Find what sum will completely pay the note on March 15.

5. A commission merchant sells goods for \$6000 and deducts his commission; he invests the proceeds in other goods, having deducted a commission at a rate greater by 1 per cent., than for selling. The two commissions amount to \$291.26; find the rates.

XVI

1. A man having \$6000 to invest has the choice of two investments, the one offering 5 per cent., principal with simple interest to be paid at the end of 12 years, the other offering 4 per cent., compound interest for the same time. Which offer should he accept?

2. A man buys a farm for \$6000 and agrees to pay principal and interest in three equal annual payments; find the annual payments if money is worth 5 per cent.

3. Employing the fact that \$100 lent now at the rate of 4 per cent., for 7 years, will bring in \$4 at the end of each year for 7 years, and \$100 at the end of 7 years, to find the value of an annuity of \$1, starting now and running 7 years, the rate of interest being 4 per cent.

4. A man has real estate from which he receives an income of 10 per cent., of its value. He pays a tax of $19\frac{1}{4}$ mills on the dollar on this income and on an assessment of $\frac{1}{4}$ of the value of the real estate. Find the virtual rate of taxation on the value of the property.

5. To appointments of a certain class the initial salary attached is \$800, and the annual increase is \$100. At the end of 3 years it is found advisable to make the initial salary \$1000, the annual increase to continue the same. In way of consideration for those appointed 3 years earlier, it is arranged that for their third, fourth, and fifth year the annual increase will be \$200. Examine this adjustment.

XVII

1. A man having \$7500 to invest may place it in a Savings Bank which allows 3 per cent., compounded yearly, or deposit with a Loan Company which allows $3\frac{1}{4}$ per cent., compounded yearly. How much will he gain at the end of 10 years by choosing the better investment.

2. A 60-day note made May 5 for \$600 with interest was discounted June 15, at 5 per cent., and the proceeds were \$602.32; find from this the rate of interest the note was bearing.

3. What sum of money invested now at 5 per cent., per annum will at the end of four years provide for a perpetuity of \$500?

4. What sum should be paid for a \$100 debenture to run for 20 years at 4 per cent., per annum, in order that the investor may realize 5 per cent., per annum on his outlay?

5. A commission merchant charges twice the rate for investment that he charges for selling. He sells a consignment for \$9600, and reserving his two commissions, invests in other goods. His two commissions amount to \$553.85; find the rates.

XVIII

1. Find the rate per annum which compounded half-yearly would give the same return as $4\frac{1}{2}$ per cent., compounded yearly.

2. A mortgage for \$1200, bearing interest at 6 per cent., has three years to run. It is offered for sale: how much should a man, wishing to have his money invested at 5 per cent., pay for it?

3. A person buys 6 per cent. bonds, the interest on which is payable yearly, and which are to be paid off at par 3 years after the time of purchase. If he invests his interest when received at 4 per cent., what should he pay for the bonds to realize 7 per cent., on his money?

4. A man has a net income of \$2,312.20 from a fixed salary and the rent of a house. On the house which rents at \$50 a month there is a mortgage of \$2000 at 6 per cent., \$4000 insurance at $1\frac{1}{2}$ per cent., taxes at the rate of 19 mills on the dollar on an assessment of \$5000, and on his salary a tax of 10 m. on the dollar with \$400 exempt. What is his salary?

5. A London merchant owes 36,000 roubles in St. Petersburg; for 3 months' bills the rate in London on St. Petersburg is 24.94 pence a rouble, and the rate in St. Petersburg on London is 9.4 roubles a pound; the rates of discount in London and St. Petersburg being 3 and 4 per cent., find whether the merchant should buy a bill on St. Petersburg, or have his agent in St. Petersburg draw on London.

XIX

1. Employ the interest tables to find, to days, the time required for a sum of money to double itself at the rates 3, $3\frac{1}{2}$, 4, $4\frac{1}{2}$ and 5 per cent.

2. The proceeds of a 90-day note for \$640, with interest at $4\frac{1}{2}$ per cent., discounted Aug. 3, 1904, at 5 per cent., were \$644.15. Find when the note was made.

3. Find the present value of a perpetuity of \$600 to start 5 years from now if money is taken as worth $3\frac{1}{2}$ per cent.

4. A mortgage of \$3000, bearing interest at 5 per cent., has 6 years to run; find its present value, interest at 4 per cent.

Find also the annuity based on the rate 4 per cent., which in the 6 years would discharge the interest on the mortgage, and the mortgage itself.

5. The profits of a loan company for a year were sufficient to enable the directors to add \$20,000 to a reserve fund, to pay \$5965 for cost of management, to pay two half-yearly dividends of $3\frac{1}{2}$ per cent., on a paid-up capital stock of \$300,000, and to have still on hand \$4236. Find the profits for the year.

XX

1. To find approximately the time required for a sum of money to double itself at ordinary rates the following rule is given: *Divide 70 by the number giving the rate per cent., and the result is nearly the number of years required.* Test this for the ordinary rates.

2. The estimated profits from a business for the next 3 years are estimated to be \$5000, \$6000, \$7000; find the present value of the estimated profits and compare it with the present value of profits for 3 years of \$6000 each year, the rate of interest being 5 per cent.

3. A person buys 4 per cent. bonds, the interest on which is payable yearly; if the bonds are to be paid 3 years after purchase and money is worth $3\frac{1}{2}$ per cent., what price should be given for the bonds?

4. A certain appointment carries with it a salary of \$800 with an annual increase of \$40. An applicant proposes that the increase be \$10 each half-year, and the proposal is accepted. Shew that the appointee is the gainer, and find the gain in salary receipts in 5 years.

5. An agent's rate of commission buying is $\frac{1}{4}$ of his rate for selling. He sold a consignment for \$10,200, and after deducting \$450 for his two commissions, invested the balance. What did he charge for selling?

MENSURATION

I

1. The sides of a triangle are 15.7 ft., 18.3 ft., 19.5 ft. in length; find the area of the triangle.
2. The middle points of the sides of a regular hexagon are joined to form another regular hexagon, and if the side of the first is 10.8 cm. long, find the area of the second hexagon.
3. How many bricks, 9 inches long, $4\frac{1}{2}$ inches broad and 4 inches thick will be required to build a wall 45 ft. long, 17 ft. high and 4 ft. thick, supposing the mortar to increase the volume of each brick $6\frac{1}{2}$ per cent.?
4. The internal radius of a ring is 24 dm. and its area is 1400 sq. dm.; find its width.
5. What is the cost of polishing a cylindrical marble pillar, 2 ft. 6 in. in diameter and 12 ft. long at \$1.25 a square foot?

II

1. The sides of a triangle are 15.37 dm., 17.32 dm., 19.53 dm., in length. Find the area of the triangle and the lengths of the perpendiculars from each angle to the opposite side.
2. Find the area of the quadrilateral ABCD, given that the lengths of AB, BC, CD are 50 rods, 40 rods, 24 rods, and that the angles at B and D are 60° and 90° .
3. The external dimensions of a rectangular iron chest are 2 ft. 3 in., 1 ft. 8 in., 1 ft. $2\frac{1}{2}$ in., and the sides, lid and bottom are one inch thick. Of how many cubic inches of iron is it formed?
4. A circle is inscribed in a sector of a circle of angle 60° ; find the area of the circle.
5. The height of a cylindrical cistern is equal to the diameter of its base; if the cistern holds 800 gallons, find the radius of the base.

III

1. A ladder with its foot 7 feet from a wall reaches to a point on the wall 24 feet from the ground. The ladder is pulled out 3 feet further from the wall; find to what height on the wall it will now reach.

2. The sides of a rhombus are 45 cm. long and one diagonal is 51 cm. long; find the area of the rhombus.

3. A closed rectangular box, 18 in. by 24 in. by 27 in. in external measurement, and made of iron plate one inch in thickness, is filled with sand; if the specific gravity of iron and sand are 7.2 and 1.6, find the weight of the filled box.

4. The diameter of a circle (radius = r) is produced until the part produced is equal to the radius, and from the extremity of the produced line tangents are drawn to the circle; find the area of the figure formed by the tangents and the arc which they intercept; find also the length of the arc.

5. A pipe 2 inches in diameter delivers water into a tank 18 feet square with a velocity of 12 feet a second; how long will it take to fill the tank to a height of 7 feet?

IV

1. The side of a regular hexagon is 72 cm. in length; find to two decimal places the distance between two opposite sides.

2. A rectangular field contains 7 ac., and its width is to its length as 7 to 10; find the cost of fencing it at \$1.75 a rod.

3. The external length, breadth and height of a closed rectangular wooden box are 18, 10 and 6 inches, respectively, and the thickness of the wood is half an inch. When the box is empty it weighs 15 pounds, and when filled with sand 100 pounds. Compare the weights of equal bulks of wood and sand.

4. I place a straight pole upon the bottom of a pond, so that it emerges perpendicular to the surface of the water, and mark a point 6 inches above the surface; then gently declining the pole (keeping its lower end fixed upon the bottom) from its upright position, I find that the mark becomes just submerged at the distance of 40 inches from the pole's first position; find the depth of the water.

5. A cubic metre of copper is drawn out into wire a centimetre in diameter; find the length of the wire.

V

1. The sides BC, CA, AB of a triangle are 52 cm., 56 cm., 60 cm., in length: a straight line DE is drawn parallel to BC to meet the sides AB, CA in D, E; DE is distant 36 cm. from A. Find the area of the triangle ADE.

2. A rectangular field contains 30 ac., and the distance from one corner to the opposite corner is 100 rods; find the perimeter of the rectangle.
3. The area of each of the longer walls of a room is 330 square feet; the area of each of the other walls is 220 square feet; the area of the floor is 384 square feet. Allowing $\frac{1}{4}$ of area of walls for doors and windows, how many yards of paper, 18 inches wide, are required to cover the walls?
4. Two equal circles of radius 7.2 dm. touch each other and a common tangent is drawn. Find the area between the common tangent and the two circles.
5. A cube of side 18 inches long and a cylinder of height 18 inches, have the same surface; compare their volumes.

VI

1. A ladder 30 feet long just reaches a window in a house on one side of a street 42 feet wide; it is then turned about its lowest point and just reaches a window on the other side. If the two positions of the ladder be at right angles, find the height of the windows.
2. A regular hexagon, each side of which is 36 feet long, is surrounded by a path 3 feet wide, the external figure being also a regular hexagon; find the area of the path.
3. A garden whose width is 9 rods and length 15 rods is to have a wall $2\frac{1}{2}$ feet thick around it outside. What will be the cost of digging a trench for it, $2\frac{1}{2}$ feet deep, at 1 $\frac{1}{2}$ c. per cubic foot?
4. The diameter of a circle is 18.4 cm.; concentric to this circle are described two other circles; if these circles divide the area of the given circle into three equal parts, find their radii.
5. An iron boiler is in the form of a cylinder with hemispherical ends; the diameter of the cylinder is 2.4 feet and its extreme length is 6 feet; find the weight of the water necessary to fill the boiler, and the number of gallons.

VII

1. The length of the sides taken in order of a quadrilateral field are 20 rd., 21 rd., 21 rd., and 22 rd., and the angle between the first and second of these sides is a right angle. Find the area of the field to the nearest square rod.

2. A room is 22 feet long and 18 feet wide. It is proposed to make a carpet for it, leaving a strip of the floor, of uniform width, adjacent to the walls uncovered, this strip to be not more than 2 feet and not less than 1 foot wide. The "square" is to be made up with a border in the usual way, and the strips of carpet in the body of it are to run in the direction of the length of the room. The carpet (both body and border) is 27 inches wide and cost \$1.75 a yard.

Make a drawing to shew the amount of carpet used and find the cost, allowing 10 cents a yard for the making up of the square.

3. A rectangular field, whose width is $\frac{2}{3}$ of its length, contains 15 acres, 123 per. In going from one corner to the opposite, how much shorter is it to take the diagonal than to go around the two sides?

4. A circular race-course is 22 yds. wide and has an area of 12 acres. Find the diameter of the inner circle.

5. A cylindrical boiler with flat ends is 18 feet long and 4.5 feet diameter, internal measurements; it is traversed lengthwise by 40 fire tubes each 3.5 inches in diameter. Find the contents of the boiler.

VIII

1. The sides of a triangle are in length 75 cm., 87 cm., 108 cm.; find the length of the side of an equilateral triangle of equal area.

2. To measure the height of a spire an observer places a rod 8 feet long upright at a distance 180 feet from the foot of the spire; retiring 6 feet in the line of the rod and the spire, he finds that the top of a rod 4 feet high is in line with the top of the other rod and the top of the spire. Find the height of the spire.

3. Find the number of cubic yards in an excavation for a ditch one-half a mile long, 6 feet wide at the top, 4 feet wide at the bottom, and 3 feet deep.

4. Find the radii and areas of the circles inscribed, circumscribed and escribed to an equilateral triangle, the side of which is 1 dm. long.

5. A closed copper cylinder is made from plate $\frac{1}{4}$ in. in thickness; the external dimensions of the cylinder are, height 22.5 in., radius 4.5 in. Find the volume of copper and the contents of the cylinder.

IX

1. A triangle of altitude 8 inches is divided into two equal parts by a straight line parallel to the base. Find where this line cuts the altitude.

2. Devise a method of finding the width of a river by employing two rods on one side of the river.
3. The dimensions of a rectangular solid are as 5 to 6 to 7, and the area of its surface is 1712 square inches; find its volume.
4. Three circles, the radii of which are $3\sqrt{3}$, $6\sqrt{3}$, $12 - 6\sqrt{3}$ inches long, touch one another externally, forming a sort of triangular enclosure; find the area and the perimeter of this figure.
5. A circular cylinder, with base of radius 15 inches, is cut off by a slant plane; the greatest height of the resulting solid is 56 inches and the smallest is 36 inches. Find the curved surface and the volume.

X

1. The middle points of the alternate sides of a hexagon, each side of which is 96 cm. long, are joined to form an equilateral triangle; find the area of the triangle.
2. Two adjacent sides of a parallelogram are 105 in. and 72 in. in length. The perpendicular distance between the two shorter sides is 45 in.; find the perpendicular distance between the other two sides.
3. A right prism stands on a quadrilateral base ABCD; AB, BC, CD, DA, measure 27 in., 42 in., 39 in., 36 in., and the angle at A is a right angle. Find the volume of the prism.
4. Three equal circles of radius 10.8 cm. touch each other; a fourth circle is described, within the triangular enclosure formed by the circles, to touch the three circles; find its area and the area of the parts into which it divides the triangular figure.
Construct the similar problem for the circle touching all three circles and having them within it.
5. A cube of side 8 in. and a cylinder with a base of radius 4 in. have the same volume; compare their surfaces.

XI

1. The sides AB, BC, CD, DA, and the diagonal AC of a quadrilateral are 37 yd., 41 yd., 53 yd., 59 yd., 29 yd. in length; find the area.
2. Three spheres of lead whose radii are 3 in., 4 in., 5 in., are melted down and recast into a sphere. Find its radius and compare the area of its surface with the sum of the areas of the surfaces of the three spheres.

3. The surface of a sphere is divided into zones: the central zone is 60° wide, the two intermediate zones each 30° wide. Compare the areas of the zones.

4. A triangle whose sides are 5 in., 12 in., 13 in., in length is made to rotate about the side whose length is 13 in. Find the surface and the volume of the solid generated.

5. What is the area (1) of a sphere, (2) of a right circular cone the angle at the vertex of which is 90° , which have the same volume as a circular cylinder 12 in. long, of which the radius of the base is 5 in.?

XII

1. The sides AB, BC, CD, DA, are 73 dm., 85 dm., 91 dm., 99 dm. in length, and the angle ABC is 45° ; find the area of the quadrilateral.

2. A sphere of gold 1 dm. in diameter is hammered out into a circular sheet 0.01 mm. in thickness; find the radius of this sheet.

3. A sphere and a regular tetrahedron have the same surface, 100 sq. in.; compare their volumes.

4. A conical tent whose slant height is 12 feet requires 132 sq. feet of canvas to make it; how much ground does the floor of the tent cover?

5. A bell tent is 16 feet high. A man 6 feet high can stand erect at a distance of 4 feet from the tent-pole. Find the air space in the tent and the area of canvas.

XIII

1. A tetrahedron has each face an equilateral triangle of side 4 inches; find the volume and the surface.

2. A sphere of metal of radius 5 inches is recast into the form of a pyramid on a square base of side 5 inches. Find the height of the pyramid.

Compare also the area of the surfaces of the two solids.

3. A sphere is 6 inches in diameter. From a point, in a diameter produced, 2 inches from the surface a tangent cone is drawn. Find the area of the part of the sphere within the cone, and the volume of the space contained by the sphere and the cone.

4. A cone of height 27 cm. is divided into three equal parts by two planes drawn parallel to the base. Find the distance between the planes.

5. A cone of height 8 inches and with a base of radius 3 inches is cut by a plane in such a way as to give a frustum of volume 48 cubic inches. Find the area of the surface of the frustum.

XIV

1. The imperial bushel measure is a hollow cylinder, the internal diameter of which is twice the depth. Find the diameter and the depth.
2. A sphere of 8 in. radius rests on a table; find the volume of the hollow cone, the section of the cone through the axis being an equilateral triangle, which can just cover it.
Find also the area of the two parts of the surface of the sphere, and the volume of that part of the cone which is above the sphere.
3. If a spherical shell when formed into a solid sphere be equal in volume to its own cavity, what must be the thickness of the shell?
4. A right circular cone of lead of height 6 in., and with a base of radius 7 in., is melted and cast into the form of a spherical shell 1 in. thick. What is the diameter of the outer surface of the shell?
5. Water is poured from a rectangular tank to fill a circular pail of height 12 in., the diameters of the top and bottom of which are 28 in., and 14 in. By how much will the water in the tank be lowered, the tank being 4 feet long and 2 feet wide?

XV

1. The base of a pyramid is a triangle whose sides are 6.5 in., 7.0 in., 7.5 in., in length, and the volume of the pyramid is 56 c. in. Find the height of the pyramid.
2. Find the surface and the volume of the zone of a sphere, the radii of the two ends being 10 in. and 4 in., and the thickness of the zone being 8 in.
3. A hemisphere, radius 6 in. and a cone of height 12 in., and with a base of radius 6 in., are placed with their bases coincident so that the two solids form one body. Find the volume of the sphere the surface of which is the same as that of this solid.
4. Find the surface and the volume of the frustum of a cone of slant height 7 in., the radii of the ends being 4 in. and 10 in.
5. The wall of a circular cistern is built of brick. The inner diameter of the top is 21 feet and of the bottom is 42 feet. The thickness of the wall at the top is $3\frac{1}{2}$ feet and at the bottom is 7 feet. Find the volume of the wall if its height is 10 feet. (Take $\frac{22}{7}$ as the approximation for π).

EXERCISES

BEARING ON

PHYSICS AND CHEMISTRY

I

1. Explain what is meant by saying that, at a certain instant, a train is moving at the rate of 35 miles an hour.

Express this rate in kilometres an hour, correctly to the second decimal place.

2. The rate at which a train is moving is given as 50 kilometres an hour; express this rate in miles an hour, correctly to the second decimal place, and also to the nearest quarter-mile.

3. A train, moving at the rate of 10 miles an hour, increases its speed uniformly for 10 minutes and is then found to be moving at the rate of 20 miles an hour; find its average speed for the 10 minutes, and the distance traversed in that time.

4. A train is moving at the rate of 15 miles an hour; it increases this rate uniformly at such a rate that in one hour its speed would be 25 miles an hour; find its speed at the end of 15 minutes, and the distance traversed in that time.

5. Falling bodies increase their velocity 32 feet a second in a second. A body is allowed to fall from rest; find its velocity at the end of 3 seconds, the average velocity for the 3 seconds, and the distance through which it fell in that time.

II

The specific gravity of a substance is a number which expresses the ratio between the weight of the substance and that of an equal volume of water.

The weight of a cubic foot of water is 1000 ounces; the weight of a cubic centimetre of water is 1 gramme.

1. The weight of 60 c. cm. of gold is 1158 grammes; find the specific gravity of gold.

2. The density of a substance being defined as the mass (weight) in grammes of 1 c. cm. of that substance, shew that the same number gives the density and the specific gravity of the substance.

3. An alloy is made of 80 c. cm. of a metal of sp. g. 19.3, 4 c. cm. of a metal of sp. g. 10.55, and 2 c. cm. of a metal of sp. g. 8.5; find the sp. g. of the alloy.

4. Equal volumes of copper (sp. g. 8.9), zinc (sp. g. 7.2) and tin (sp. g. 7.3) are taken to form an alloy; find the sp. g. of the alloy.

5. If 100 pounds of copper is drawn into 1 mile of wire, find the diameter of the wire, the specific gravity of copper being 8.9.

III

In the Centigrade thermometer the interval between the temperatures corresponding to the freezing and boiling points of water is divided into 100 degrees, and the points marking the intervals are numbered from 0 to 100; the same interval in Fahrenheit's thermometer is divided into 180 degrees, and the points are numbered from 32 to 212.

1. Find the readings of the Centigrade thermometer corresponding to the following readings Fahrenheit:

10°, 50°, 90°, 120°, -10°.

2. Find the readings of Fahrenheit's thermometer corresponding to the following readings Centigrade:

2°, 20°, 50°, -10°, -273°.

3. Express a pressure of 15 pounds on a square inch in grammes on a square centimetre.

Find a decimal multiplier which will convert pounds (pressure) on a square inch into grammes (pressure) on a square centimetre.

4. The pressure of the atmosphere is frequently given by the reading on a barometer, which indicates the height of a column of mercury which would give the same pressure. If the barometric reading is 29.5 inches, find the corresponding reading for a graduation in millimetres.

5. In the definition of the gallon occur the words: "*at the temperature of sixty-two degrees of Fahrenheit's thermometer, and with the barometer at thirty inches.*"

Find the equivalent measures for the Centigrade thermometer and a barometer graduated in millimetres.

IV

Experiment shows that, in the case of metals as lead, iron, gold, etc., if a unit length be taken at $0^{\circ}\text{C}.$, each advance of 1° in temperature is accompanied by a certain increase in length, the same (practically, if the change in temperature is not great) for each degree. Thus 1 inch of lead wire at $1^{\circ}\text{C}.$ increases 0.000028 in. for each increase of 1° in temperature; 0.000028 is called the coefficient of linear expansion of lead.

1. A rod of lead 7 in. long at $0^{\circ}\text{C}.$ Centigrade is heated to $9\frac{1}{2}^{\circ}\text{C}.$; find its length at that temperature.
2. A plate of lead 7 in. by 5 in. at $0^{\circ}\text{C}.$ is heated to $11^{\circ}\text{C}.$; find the area of the plate at the new temperature, taking 0.000028 as the coefficient of linear expansion.
3. A cube of gold 1 c.cm. in volume at $0^{\circ}\text{C}.$ is heated to $9^{\circ}\text{C}.$; find the increase in volume if the coefficient of linear expansion of gold is 0.000014.
4. A piece of brass wire is found to be 200.0375 mm. long at $10^{\circ}\text{C}.$; find its length at $20^{\circ}\text{C}.$ if the coefficient of linear expansion of brass is 0.00001875.
5. A piece of silver wire is 300.057 dm. in length at $10^{\circ}\text{C}.$ and 300.114 dm. in length at $20^{\circ}\text{C}.$; find the coefficient of linear expansion of silver.

V

Experiment shows that, if a given volume of a gas at $0^{\circ}\text{C}.$ be heated, each advance of 1° in temperature is accompanied by an increase in volume equal to $\frac{1}{273}$ of the volume at $0^{\circ}\text{C}.$, provided the pressure on the gas is kept the same. Experiment also shows that if the temperature of a gas is kept constant while the pressure is changed, the volume at any two times is inversely proportional to the pressures at those times.

1. A volume of gas of 24 c. ft. at $0^{\circ}\text{C}.$ is heated to $20^{\circ}\text{C}.$; find its volume at this temperature.
2. A certain quantity of gas occupies 30 c. m. at $20^{\circ}\text{C}.$; find its volume at $40^{\circ}\text{C}.$
3. If 25 c. cm. of a gas at $20^{\circ}\text{C}.$ becomes 30 c. cm. under a change of temperature, find the new temperature.
4. The volume of a gas at a pressure of 770 mm. is 400 c. cm.; find its volume at a pressure of 760 mm.
5. The volume of a gas at 760 mm. pressure is 450 c. cm. and under a change of pressure its volume becomes 420 c. cm.; find the new pressure.

VI

The volume of a gas is proportional to its weight, and to the "absolute temperature" (degrees Centigrade plus 273), and inversely proportional to the pressure to which it is subjected.

1. If one gramme of air at 760 mm. pressure and 0°C . occupies 773.4 cc., what will the volume of seven grammes of air at 750 mm. and 15°C . occupy?
2. At what temperature will five grammes of air occupy 5 litres, the pressure being 760 mm.?
3. What is the pressure of a litre vessel containing one gramme of air 25°C .?
4. What is the weight of two litres of air at 770 mm. pressure, and 10°C . below zero?
5. If a fixed quantity of gas occupy one litre at 17°C . and 765 mm., what will be its volume at 40°C . and 720 mm.?

VII

When zinc is dissolved in sulphuric acid, hydrogen gas is formed; and the weight of gas formed is proportional to the weight of zinc dissolved.

1. If one gramme of zinc, when dissolved in sulphuric acid, yields 394 c.cm. of hydrogen gas, measured at 15°C . and 730 mm. pressure, how much zinc must be dissolved to prepare 15 litres of hydrogen, measured at 100°C . and 800 mm.?
2. If one gramme of zinc, dissolved in sulphuric acid, yields 394 c.cm. of hydrogen gas, measured at 15°C . and 730 mm. pressure, how many litres of hydrogen at 20°C . and 740 mm. pressure will 5.3 grammes of zinc yield when dissolved in sulphuric acid?
3. If one gramme of zinc, dissolved in sulphuric acid, yields 394 c.cm. of hydrogen gas, measured at 15°C . and 730 mm. pressure, and 5 grammes dissolved in sulphuric acid yield 2035 c.cm. at 30°C ., find the pressure.
4. If one gramme of zinc dissolved in sulphuric acid yields 373.5 c. cm. of hydrogen gas measured at 0°C . and 730 mm. pressure, and 3 grammes yield 113.5 c. cm. at a pressure of 740 mm., find the temperature.
5. The "molecular weight" of a gas is the weight in grammes of 22.4 litres at 0°C . and 760 mm. pressure.
If 1200 c.c. of carbonic acid gas measured at 100°C . and 430 mm. weigh 0.977 grammes, what is its molecular weight?

TEST PAPERS

I

1. Find, by contracted methods correctly to 3 places of decimals, the value of

(a) 7.3218×2.0723 ;

(b) $3.5729 \div 5.3827$.

2. Find two numbers such that their difference will be 18 and that $\frac{3}{4}$ of one will be equal to $\frac{1}{4}$ of the other.

3. A note for \$182.50 is payable on the 7th of September; on the 4th of July it was discounted at a bank at the rate of 6 per cent. Find the net proceeds.

4. By selling 40 yd. of cotton for a certain sum of money a merchant gains 25 per cent. How many yards can he give for the same money if he decides to advance his profit to 50 per cent.?

5. A man bought 150 shares of 6 per cent. stock at 118 $\frac{1}{2}$, received the half-yearly dividend, and sold at 119 $\frac{1}{2}$; brokerage on each transaction being $\frac{1}{2}$ per cent.; find by how much he increased his capital.

6. A and B jointly buy a bankrupt stock for \$7000, A subscribing \$3000 and B \$4000. A, acting as agent, sells the goods at an advance of 35 per cent. Out of the proceeds A is to receive 10 per cent. as commission, and the rest is to be divided in the ratio of the amounts subscribed. Find the share of each.

7. The sides of a triangle are 54 yd., 59 yd., 67 yd., long; find its area and the length of the perpendicular to the longest side.

8. A circular field containing 12 acres is surrounded by a race track 15 yards wide. Find the area of the track, taking 3.1416 as the ratio of circumference to diameter.

9. A cylinder standing on a base of 12 cm. radius is 25 cm. high. Find the edge of a cube of the same volume.

II

1. Find to three places of decimals, preferably by contracted methods,

(a) 3.572×0.2357 .

(b) $1.3275 \div 3.5934$.

2. A merchant bought 600 pounds of tea at 30 cents and 800 pounds at 40 cents; he mixed the two kinds and sold the mixture at 50 cents. Find his gain per cent.
3. A cistern has three supply pipes which would fill it in 30 min., 40 min., 50 min., respectively. How long would it take all three pipes to fill the cistern?
4. At the beginning of each year, for 3 years, a man deposits \$400 in a savings bank which allows $3\frac{1}{2}$ per cent. per annum compounded half-yearly. What amount has he to his credit in the bank at the end of the third year?
5. A note for \$120 made Jan. 13, 1905, at three months, bearing interest at 4 per cent., is discounted on Feb. 17 at 5 per cent. Find the proceeds.
6. On May 15, a man buys 80 shares of stock at 123, on July 1 receives the half-yearly dividend at 6 per cent. per annum, and on July 7 sells at 126. If brokerage on each transaction is $\frac{1}{2}$ per cent., find to what extent his capital has been increased by the transaction.
7. A teacher's salary of \$800 is paid in four quarterly payments at the end of each quarter. Find what sum paid at the beginning of the year is the equivalent of these payments, reckoning compound interest at $1\frac{1}{2}$ per cent., a quarter.
8. The sides of a triangular field are 160 yd., 180 yd., 210 yd. in length. Find its area, and the length of the perpendicular to the longest side, each to two places of decimals.
9. A chord of a circle, whose radius is 18 feet, subtends a right angle at the centre of the circle. Find the area of the smaller segment of the circle, taking 3.14 as the approximate value of the ratio of the circumference to the diameter.

III

1. (a) Assuming that $0.\dot{4}\dot{6} = \frac{7}{15}$ explain how to find the vulgar fraction equivalent to $0.7\dot{4}\dot{6}$.

(b) Find to two decimal places

$$\sqrt{11}, \sqrt{0.7}, \sqrt{\frac{1}{11}}.$$

2. Of a certain mixture of wine and water 40 per cent., is water; if 16 gallons more wine be added, only $33\frac{1}{3}$ per cent., of the mixture will be water. Find the quantity of wine and of water in the mixture.
3. There are two numbers the sum of which is 111, and 16 per cent. of one is equal to $33\frac{1}{3}$ per cent., of the other; find the numbers.

4. Find the proceeds of a note for \$340, payable on August 13, 1905, and discounted, July 3, at the rate of 5 per cent.

5. A owes B \$750, to be paid at the end of 3 years; if interest is at the rate of $4\frac{1}{2}$ per cent., find what sum paid now would meet the debt.

6. A instructs his broker to buy for him 70 shares (\$100 each) of a certain 6 per cent. stock. The broker buys at $137\frac{1}{2}$, brokerage $\frac{1}{2}$ per cent.; find for what sum the broker will draw on A.

If later the broker sells the stock for A, after the payment of the half-yearly dividend at $140\frac{1}{2}$, brokerage $\frac{1}{2}$ per cent., what sum will the broker remit to A?

7. If an ordinary brick measures $8'' \times 4'' \times 2''$, and 81,000 such bricks are piled in the form of a rectangular solid whose length, width and height are proportional to 4, 3 and 2, find the dimensions of the pile.

8. A cube of copper, the edge of which is 5.7 cm. long, is drawn out into wire of 1 mm. diameter; find the length of the wire.

9. Find the area of a triangle the lengths of whose sides are 112 in., 127 in., and 143 in.

IV

1. (a) Find, correctly to three places of decimals, the value of

$$\frac{3.7254 \times 2.1379}{13.3753}$$

(b) Find to three places of decimals

$$\sqrt{17}, \sqrt{\frac{1}{17}}, \sqrt[3]{0.37}.$$

2. Find the G. C. M. and the L. C. M. of

$$\frac{1}{11}, \frac{1}{14}, \frac{1}{17},$$

giving full explanation.

3. A note for \$800 made May 7, at 90 days with interest at 4 per cent., is discounted June 11, at the rate of 5 per cent.; find the proceeds and the rate of interest made by the banker on the money advanced.

4. I sent a quantity of goods to a commission merchant with instructions to sell, and, after deducting his commission, to invest the proceeds in sugar which is quoted at 3¢. per lb. He charges 3 per cent., commission for selling and $2\frac{1}{2}$ per cent., for buying, and his total commissions amount to \$297. How many pounds of sugar did he buy?

5. From the fact that 4 per cent. standard stocks are selling at 93, calculate the sum that should be paid at the present time to discharge a debt of \$4300 due ten months hence.

6. A debenture of \$10,000, paying 4 per cent., is to be paid off in 3 years; what sum should a man, seeking 5 per cent. investment for his money, offer for it?

7. A cubic foot of water weighs 1000 ounces, and a quart of water weighs 2½ pounds. How many quarts will a common pail hold which is 12 inches in diameter at the top, 8 inches at the bottom, and 7 inches deep?

8. A metal cone is 2 feet high, and the area of the base is 154 sq. inches. It is melted down and recast into another cone the radius of whose base is only $\frac{2}{3}$ of that of the former one. Find the height of the new cone.

9. The volume of a sphere is 108 c. cm.; find the area of its surface.

INDEX

Introduction	5-8
Unitary Method and Proportion	
Algebraical and Arithmetical Solutions	
Miscellaneous Examples	9-19
Commercial Examples	20-30
Mensuration	31-37
Physics and Chemistry	38-41
Test Papers	41-45

POPULAR TEXT BOOKS

HIGH SCHOOL ARITHMETIC. By A. T. DeLury, M.A., Associate Professor of Mathematics, University of Toronto. 60 cents.

"Undoubtedly the best treatise on the subject that has yet appeared."

HIGH SCHOOL GEOGRAPHY. By G. A. Chase, B.A., Jarvis Street Collegiate Institute, Toronto. \$1.00.

"The only book approaching physical geography, astronomy and commercial geography from the Canadian standpoint."

PRINCIPLES AND PRACTICE OF ORAL READING. By Miss A. E. Marty, M.A., Collegiate Institute, Ottawa. 50 cents.

"Highly recommended as a thoroughly practical book on a difficult subject by a successful teacher."

HIGH SCHOOL GRAMMAR. By John Seath, LL.D., Inspector of High Schools and Collegiate Institutes for Ontario. 75 cents.

"An excellent text characterized by broad treatment, sound scholarship and clear statement."

PUBLIC SCHOOL GEOGRAPHY with a supplement, covering fully the physical geography prescribed for Continuation Classes and the Lower Forms in High Schools. 75 cents.

"A comprehensive, practical, and up-to-date geography covering the prescribed Course."

Canada Publishing Company
TORONTO Limited

