HULL'S MENTAL ARITHMETIC. A MENTAL ARITHMETIC, BASED ON ANALYSIS AND INDUCTION

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BY

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PREFACE.

THE object of this book is to give the pupil that *power of analysis* which is neither furnished by a course in Written Arithmetic nor acquired by the study of Algebra, and yet is essential to the easy mastery of mathematics.

A mistake is sometimes made in regarding Mental Arithmetic as Oral Arithmetic merely. This places the process, or form of solution, above the principle that underlies a system of mental arithmetic, and leads to false methods of instruction. Though mental arithmetic is generally oral, and should be eminently practical, yet its essential feature is not necessarily either. The end to be attained is *analytic power*. This is accomplished by analysis, comparison, and induction.

The author has tried to make the work as practical as possible, while keeping steadily in view the distinctive feature of the subject; also to make the course comprehensive, logical, and progressive.

Great care has been taken in the construction of problems, to make them neither too difficult, thus requiring the aid of written characters, nor too easy, thus depriving the pupil of the power that comes from patient effort.

GEORGE W. HULL.

MILLERSVILLE, PA., }
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INTRODUCTION.

ATTENTION is called to the following suggestions.

Elementary Results.—It is readily perceived that there is a number of elementary results which we have no means of deriving except through the process of counting. Thus, if we are asked to add 4 units to 5 units, we have no means of obtaining the result except to count from 5 to 9.

These elementary results are the *sums of the addition table and the products of the multiplication table, with their corresponding differences and quotients.* No great progress can be made in arithmetic until these elementary results are mastered.

It should be remembered that each elementary result is formed of *only* two numbers of one figure each. Thus, $4 + 5 = 9$ and $4 \times 5 = 20$ are elementary results; but $15 + 3 = 18$, $4 + 8 + 3 = 15$, and $3 \times 5 \times 6 = 90$, are *not* elementary results.

It should also be remembered that the highest possible elementary sum is $9 + 9 = 18$, and the highest possible elementary product is $9 \times 9 = 81$. This means, not that the addition table cannot extend above $9 + 9 = 18$, nor the multiplication table above $9 \times 9 = 81$, but that there is no absolute necessity for them beyond these limits.

The first step, therefore, in Arithmetic is to familiarize the pupil with these elementary results. Since a child, in acquiring knowledge, deals first with the object, then with a mental pic-

ture of the object, and finally with the abstract idea, this order should be followed in teaching these elementary results: *first*, with objects; *second*, without objects; *third*, with figures.

METHODS OF RECITATION.

There are two methods now in general use of conducting a recitation in mental arithmetic. They are as follows:

1. **Without the Book.**—By this method, the teacher reads the problems and assigns them promiscuously. The pupil to whom a problem is assigned rises, repeats the problem, and solves it without the aid either of the book or of written characters. If any mistakes are made in the solution, they are corrected either by the class or by the teacher.

2. **With the Book.**—By this method, the pupil is permitted to have the book. The problems are assigned promiscuously as before. The pupil to whom a problem is assigned rises with the book in hand, and solves the problem without the aid of written characters. Corrections are made as in the other method.

In both these methods the entire class may solve the problems silently, and, when all the members of the class, or nearly all, have acquired the result, the teacher may designate some one to give the result and solve the problem.

MENTAL ARITHMETIC.

I. ELEMENTARY RESULTS.

I. ELEMENTARY SUMS.

1. RUTH had 3 cents, and Mary gave her 2 more; how many cents had she then?

SOLUTION.—If Ruth had 3 cents, and Mary gave her 2 more, she then had 3 cents and 2 cents, which are 5 cents.

2. John has 2 cents, and Louis has 1 cent; how many cents do they together have?

3. Harry had 4 apples, and bought 2 more; how many apples did he then have?

4. There are 5 boys in one class, and 2 in another; how many boys in both classes?

5. Harold had 3 marbles, and bought 3 more; how many marbles had he then?

6. A farmer had 4 horses, and bought 3 more; how many horses had he then?

7. There are 5 roses on one bush, and 3 on another; how many roses are there on both bushes?

8. A slate cost 7 cents, and a pencil 2 cents; how many cents did both cost?

9. Gilbert had 4 cherries, and his brother gave him 4 more; how many cherries did he then have?

10. A boy rode 4 miles, and walked 5; how many miles did he travel?

11. How many are 3 and 6?

FORM OF RECITATION.—3 and 6 are 9.

12. How many are—

2 and 2?	6 and 2?	2 and 3?	6 and 3?
3 and 2?	7 and 2?	3 and 3?	7 and 3?
4 and 2?	8 and 2?	4 and 3?	8 and 3?
5 and 2?	9 and 2?	5 and 3?	9 and 3?

13. James had 5 cents, and earned 3 more; how many cents did he then have?

14. Maud had 5 pinks, and gathered 4 more; how many pinks did she then have?

15. Esther paid 7 cents for a card, and 5 cents for a pencil; how many cents did both cost?

16. How many are—

2 and 4?	6 and 4?	2 and 5?	6 and 5?
3 and 4?	7 and 4?	3 and 5?	7 and 5?
4 and 4?	8 and 4?	4 and 5?	8 and 5?
5 and 4?	9 and 4?	5 and 5?	9 and 5?

17. A pound of sugar cost 6 cents, and a quart of vinegar 5 cents; how many cents did both cost?

18. Henry has 6 dollars in gold, and 7 dollars in silver; how many dollars has he of both kinds?

19. How many are—

2 and 6?	6 and 6?	2 and 7?	6 and 7?
3 and 6?	7 and 6?	3 and 7?	7 and 7?
4 and 6?	8 and 6?	4 and 7?	8 and 7?
5 and 6?	9 and 6?	5 and 7?	9 and 7?

20. James had 8 cents, and found 6 more; how many cents did he then have?

21. Ross caught 7 fish, and Horace caught 8; how many fish did they both catch?

22. How many are—

2 and 8?	6 and 8?	2 and 9?	6 and 9?
3 and 8?	7 and 8?	3 and 9?	7 and 9?
4 and 8?	8 and 8?	4 and 9?	8 and 9?
5 and 8?	9 and 8?	5 and 9?	9 and 9?

23. Helen gave 5 cents for an orange, and 9 cents for a slate; how much did she pay for both?

24. A farmer sold 6 bushels of apples to one man, and 9 bushels to another; how many bushels did he sell to both?

The process of finding the sum of two or more numbers is called Addition.

The symbol + is read *plus*. It indicates that the numbers between which it is placed are to be added.

The symbol = is read *equal* or *equals*. Thus, 5 + 3 = 8 is read 5 plus 3 *equal* 8.

25. What additions of two figures will produce 4? 5? 6?

26. What additions of two figures will produce 7? 8? 9?

27. What additions of two figures will produce 10? 11? 12?

28. What additions of two figures will produce 13? 14?

29. What additions of two figures will produce 15? 16?

30. What addition of two figures will produce 17? 18?

The simplest elementary sum is 1 + 1. The following are the eight most difficult elementary sums:

31. How many are—

8 and 9?	6 and 9?	8 and 5?	7 and 6?
7 and 8?	7 and 9?	8 and 6?	9 and 5?

TABLE OF ELEMENTARY SUMS.

1 + 2 = 3	1 + 3 = 4	1 + 4 = 5	1 + 5 = 6
2 + 2 = 4	2 + 3 = 5	2 + 4 = 6	2 + 5 = 7
3 + 2 = 5	3 + 3 = 6	3 + 4 = 7	3 + 5 = 8
4 + 2 = 6	4 + 3 = 7	4 + 4 = 8	4 + 5 = 9
5 + 2 = 7	5 + 3 = 8	5 + 4 = 9	5 + 5 = 10
6 + 2 = 8	6 + 3 = 9	6 + 4 = 10	6 + 5 = 11
7 + 2 = 9	7 + 3 = 10	7 + 4 = 11	7 + 5 = 12
8 + 2 = 10	8 + 3 = 11	8 + 4 = 12	8 + 5 = 13
9 + 2 = 11	9 + 3 = 12	9 + 4 = 13	9 + 5 = 14
1 + 6 = 7	1 + 7 = 8	1 + 8 = 9	1 + 9 = 10
2 + 6 = 8	2 + 7 = 9	2 + 8 = 10	2 + 9 = 11
3 + 6 = 9	3 + 7 = 10	3 + 8 = 11	3 + 9 = 12
4 + 6 = 10	4 + 7 = 11	4 + 8 = 12	4 + 9 = 13
5 + 6 = 11	5 + 7 = 12	5 + 8 = 13	5 + 9 = 14
6 + 6 = 12	6 + 7 = 13	6 + 8 = 14	6 + 9 = 15
7 + 6 = 13	7 + 7 = 14	7 + 8 = 15	7 + 9 = 16
8 + 6 = 14	8 + 7 = 15	8 + 8 = 16	8 + 9 = 17
9 + 6 = 15	9 + 7 = 16	9 + 8 = 17	9 + 9 = 18