
Effortless division on any mechanical adding device

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For anyone who is aware of the method of division for a Comptometer or Burroughs, dividing on the simplest adding devices becomes child's play.

As a collector, I own a range of everything from simple adding devices (Addiator type) to highly sophisticated mechanical calculating machines that can perform the four basic arithmetic operations (+ - x ÷). However, the latter were very expensive back then and as a sales representative you couldn't just take them with you. An adding device, however, was cheap and you could take it with you in your vest pocket. However, the manufacturers never explained exactly how to divide correctly with these devices!

Division was a challenge

Division can be performed by a sequence of subtractions. Simple addition devices either had no instructions for division or had a complicated procedure in the instructions. Like subtraction, this required the use of complementary numbers.

An advance were devices that could also perform subtractions, such as the simple addiator duplex: the front was for addition, the back for subtraction. This made division possible: you subtract the divisor from the left side of the dividend as often as possible and write down this number. Then you move one place to the right and repeat the subtraction, etc. This is also how you do it on paper, according to the written long division algorithm taught in schools (see https://en.wikipedia.org/wiki/Long_division).

But to record the result, you still need a pen and paper. With the following method however, you don't even need paper anymore, just an adding device.

Division on the Comptometer

A popular type of calculator has a full 10-key keyboard and a results window. Let's take the Comptometer as an example.

The Comptometer is occasionally classified as a machine for only one type of arithmetic operation (addition). Some contemporary collectors, describing the Comptometer, even forget to mention the method of division.

As if you could only do three operations (+ - x).



Fig.: Comptometer C (light) - 1912

The reason for the Comptometer's great popularity for more than 60 years was its great speed, with which all basic arithmetic operations, including division, could be carried out quickly. An example: On the Comptometer (10 columns), the author was able to do the division $355 \div 113$ in 59 seconds. With an Odhner type machine it takes 1m 26 seconds.

Don't expect this article to provide a theoretical explanation as to why this method of division works on a Comptometer. The 1895 "Methods of Operating the Comptometer" literally states: "Do not worry *why* the above process brings the answer."

NOTE.—Do not worry about *why* the above process brings the answer. It is simply an arbitrary rule, by which any and all examples in division can be computed on the Comptometer, and once understood is so simple that it cannot be forgotten. All there is to it is that you strike the

However, the curious reader will find an appendix in the 1911 edition in which the method is explained theoretically down to the smallest detail (<https://archive.org/details/MethodsOfOperatingTheComptometer>).

The publication "Easy Instructions for Operating the Controlled-Key Comptometer" also explains this method in detail and with many photos.

Division on an adding device

You only learn the method through practical application. So pick up an adding machine and calmly follow all the steps below the first time.

The only requirement for the addition device is the ability to enter digits into the various columns. An Adix is therefore not suitable, but a Kuli is. All Addiator-type devices (slide adders) are also suitable.

Essentially, the display shows the dividend at the beginning and the result of the division (quotient) at the end.

Don't be discouraged by the detailed description: Once you have understood the trick, you will be able to perform any division without any problems. Practice makes perfect!

We need to look up the complement of the divisor right away. To do this, you can consult the following table, in which each digit has its 9's complement:

digit	0	1	2	3	4	5	6	7	8	9
complement	>9<	>8<	>7<	>6<	>5<	>4<	>3<	>2<	>1<	>0<

In this article, the complement is written between angular brackets: >x<

The complement for **23** is therefore (9-2) and (9-3) or 7 and 6, written as >76<.

I call the division method the ABC method: the essential point is to repeat three steps from left to right on the device:

- A. Perform an addition as many times as the index number indicates
- B. Reduce the rest
- C. Move one column to the right

Example 1 - Divisor less than 10

As a first example, we take $90 \div 7$ on an Addiator with a 9-digit results window. The divisor consists of one digit.

Always start with an **estimate** to put the decimal point in the final result in the right place: in this case the solution will be greater than 10 ($7 \times 10 = 70$) but less than 20 ($7 \times 20 = 140$).

Follow the diagram in the below table:

Write down the result of the divisor minus 1	$7 - 1 = 6$
Find the complement of (divisor - 1)	>3<
Set the dividend on the left, with a leading zero. The first digit is called the "index" (here in red).	0 <u>9</u> 0 0 0 0 0 0 0
Step "A" Add the complement to the first number as often as the index indicates. <i>Index = 0: do nothing!</i>	0 <u>9</u> 0 0 0 0 0 0 0
Step "B" (no index needed) Reduce the remainder: add the complement of the divisor to the first number until it is smaller than the divisor. <i>9 is greater than 7: add >3<</i> <i>2 is less than 7: (next step)</i>	+ >3< 1 <u>2</u> 0 0 0 0 0 0 0
Step "C" Switch one column to the right <i>The index is now digit 2</i>	1 2 <u>0</u> 0 0 0 0 0 0
= Step "A" <i>The index is 2: add >3< in column 3 twice</i>	+ >3< 1 2 <u>3</u> 0 0 0 0 0 0 + >3< 1 2 <u>6</u> 0 0 0 0 0 0
= Step "B" <i>6 is less than 7: (next step)</i>	
= Step "C". Index is now 6.	1 2 6 <u>0</u> 0 0 0 0 0
= Step "A" <i>Add >3< in column 4 six times. Count out loud.</i> <i>The index became 7: add >3< a 7th time.</i> <i>The index became 8: add >3< an 8th time.</i>	1 2 6 <u>3</u> 0 0 0 0 0 1 2 6 <u>6</u> 0 0 0 0 0 1 2 6 <u>9</u> 0 0 0 0 0 1 2 7 <u>2</u> 0 0 0 0 0 1 2 7 <u>5</u> 0 0 0 0 0 1 2 7 <u>8</u> 0 0 0 0 0 1 2 8 <u>1</u> 0 0 0 0 0 1 2 8 <u>4</u> 0 0 0 0 0
= Step "B" <i>4 is less than 7: (next step)</i>	
= Step "C". Index = 4.	1 2 8 4 <u>0</u> 0 0 0 0

Repeat steps A, B and C as long as you can move to the right. Finally you get the end result:

= Step "A" Add >3< in column 9 twice.	1 2 8 5 7 1 4 2 <u>3</u>
= Step "B" 6 is less than 7: done!	1 2 8 5 7 1 4 2 <u>6</u>

Congratulations! By repeating steps A, B and C each time without writing down a single digit, you can now read the result of the division in the result window. The result is estimated to be between 10 and 20, so place the decimal point after the 12.

$$90 \div 7 = \mathbf{12.857142} \text{ with a remainder of } 6$$

Fig.: The result of $90 \div 7$ with 10 significant digits and a remainder on the Kuli, a simple column adder with a tens transfer in three columns.



Fig.: The result of $10 \div 7$ on a Lightning Adding Machine (1.4285 + 5 as remainder)



Example 2 – a two digit divisor (between 10 and 99)

Let's take $64 \div 17$. The divisor now consists of two digits.

The **estimation**: $64 \div 17$ is between $60 \div 10 = 6$ and $60 \div 20 = 3$. The result is thus between 3 and 6.

Write down the result of the divisor minus 1	$17 - 1 = 16$
Find the complement of (divisor - 1)	>83<
Set the dividend on the left, with a leading zero. The first digit is called the "index" (here in red).	0 <u>6 4</u> 0 0 0 0 0 0
Step "A" Add the complement to the first number as often as the index indicates. <i>Index = 0: do nothing!</i>	0 <u>6 4</u> 0 0 0 0 0 0
Step "B" (no index needed) Reduce the remainder: add the complement of the divisor to the first number until it is smaller than the divisor. <i>64 is greater than 17: add >83< 47 is greater than 17: add >83< 30 is greater than 17: add >83< 13 is less than 17: (next step)</i>	+ >8 3< 1 <u>4 7</u> 0 0 0 0 0 0 + >8 3< 2 <u>3 0</u> 0 0 0 0 0 0 + >8 3< 3 <u>1 3</u> 0 0 0 0 0 0
Step "C" . Index = 1.	3 1 <u>3 0</u> 0 0 0 0 0
= Step "A" Add >83< in columns 3 and 4. The index became 2: add >83< a 2nd time.	3 2 <u>1 3</u> 0 0 0 0 0 3 2 <u>9 6</u> 0 0 0 0 0
= Step "B" 96 is greater than 17: add >83< and so on. Finally, you got	3 7 <u>1 1</u> 0 0 0 0 0
= Step "C". Index = 1	3 7 1 <u>1 0</u> 0 0 0 0
Etcetera. The final result is:	
= Step "A". Result	3 7 6 4 7 0 1 <u>8 3</u>
= Step "B". Result	3 7 6 4 7 0 5 <u>1 5</u>

Now read the final result in the result register. The estimate of the result was less than 10, so place the decimal point behind the 3.

$$64 \div 17 = 3.764705 \text{ with } 15 \text{ as the remainder}$$

Fig.: The result of $64 \div 17$
on the Maximator (7 digits + remainder) and on the Mini-Kingson (4 digits + remainder)



Special cases for the complementary number:

- Ignore the last zeros of the divisor: Divisor 130 results in $(130 - 1) = 129$ and as complement $>870<$. The 3rd digit is useless. Therefore, use the divisor 13, which results in $(13 - 1) = 12$ and as complement $>87<$.
- The divisor 10 results in the number $>0<$ as the complement for $(10 - 1) = 9$. The addition of zeros is useless. In fact, dividing by 10 is equivalent to moving the decimal point one place to the left.
- The divisor 98 results in $(98 - 1) = 97$ and the complementary number $>02<$. The 0 retains its position, but you should not enter it.

Conclusion

Each collector can now practise this division method on a simple adding machine. However, you can also use the ABC method on any advanced calculator (with revolution counter). If the calculation is correct, you can see that the solution in the result window corresponds exactly to the number on the revolution counter.

Fig.: Result of $64 \div 17$ following the ABC division method on the advanced Hamann Manus E2. The revolution counter on the left-

hand side of the carriage shows the same result as the result window on the right-hand side of the carriage: the result is correct!



Common sense

Today, one uses a calculator for every arithmetic operation. Only rarely does someone even attempt to find a mathematical solution with his or her grey brain cells.

In the past, people were necessarily more creative in their use of numbers and calculations.

Kreative oder neugierige Zahlenjongleure können versuchen, die folgende Aufgabe zu lösen. Sie stammt aus dem wunderbaren Buch von Malba Tahan aus dem Jahr 1949 "Beremis, der Zahlenkünstler". Ein Taschenrechner ist nutzlos.

Creative or curious number jugglers can try to solve the following problem. It comes from the wonderful book by Malba Tahan from 1949 "The Man who Counted". A pocket calculator is useless.

Three brothers inherit 35 camels. Half of the inheritance goes to the eldest son, a third to the second and a ninth to the youngest.

(So the eldest is entitled to 17.5 camels, the second to about 11.6 camels and the youngest to 3.9 camels.)

The brothers argue for days because they obviously don't want to cut up the camels. Fortunately, a mathematician then happens to visit their village...

The mathematician thinks for a while and then finds an elegant solution (with unadulterated, live camels) that gives all the brothers an advantage and the mathematician a reward. Good luck!

Literature

- Methods of Operating the Comptometer; 4 editions (1895, 1911, 1921 und 1928); available at archive.org
- Easy Instructions for Operating the Comptometer; edition from 1915 (without division); available at archive.org
- Easy Instructions for Operating the Controlled-Key Comptometer; various editions (1920, 1930 etc.); available at archive.org
- O homem que calculava – Malba Tahan, pseudonym of the Brazilian Júlio César de Mello e Souza (1895 – 1974). A wonderful book full of funny stories with puzzling numbers for everyone who loves numbers and arithmetic. Still available in many languages; search for the author to find the title in your language.

All photos by the author.

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