

Working with the Soroban

An Introduction

Willi Egger

After assembling the small Soroban (Japanese abacus) during the 2024 ConT_EXt meeting there was no time to enter deeply into the use of this calculating tool. This article explains how to operate the Japanese abacus and provides exercises to get accustomed to its use.

1. Description of the *Soroban*

As already mentioned in my article “Calculation with Tools” the Soroban is a calculating frame of the Japanese style. Basically it consists of a (wooden) frame with a series of columns carrying beads. The frame is divided into two sections, where the lower part has four movable beads and the upper section has only a single movable bead. The Soroban is built with a variable number of columns, depending on the purpose of its use.

The method of using a Soroban to perform calculations is described in section 4.

The original Soroban carries markers on the dividing bar. For integer calculations they are unimportant. If one needs to calculate with decimal fractions one of these markers can be used as an indicator of the decimal separator.

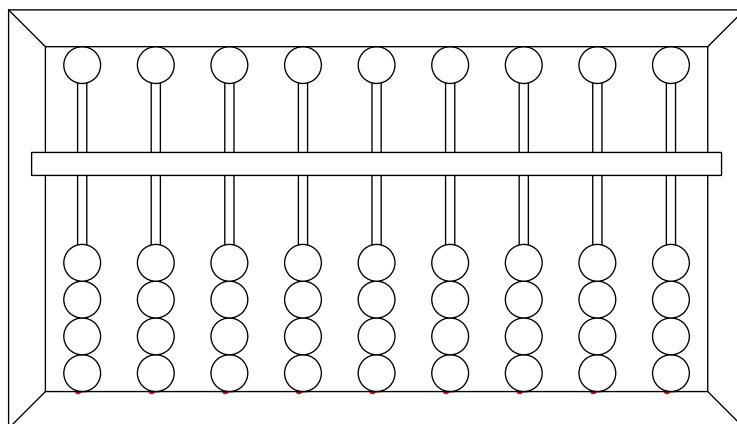


Fig. 1. Soroban model

2. Workshop

As a part of the presentation of the development of calculating tools during the 2024 ConT_EXt meeting, each participant was invited to assemble a small Soroban. Due to lack of time there was no opportunity for a lengthy demonstration. This article describes the basic techniques for using a Soroban.

3. Manual “How to use a Soroban, Japanese abacus”

The provided information is extracted from the manual “How to use a Soroban, Japanese abacus” from Tomoe Soroban Co., Ltd (www.soroban.com).

Due to the the size of the mentioned manual it has been condensed, the exercises shortened and the last section of “expert” exercises completely left out. The drawings used for this article have been created in MetaFun.

4. Operating the Beads for Counting

The placement of the tool for a user is such that the frame with its columns of beads is placed flat on the table, oriented so that the columns are vertical. The Soroban uses positional numbering, with the rightmost beads representing the lowest digits.

For starting a calculation all beads are moved to the outer frame, i.e., the dividing bar of the Soroban has no beads touching it. Moving beads from the frame toward the dividing bar makes them counting beads. The rightmost column is used to represent the numbers 0 up to 9, the next column to the left counts for 10 up to 90. Each further column to the left represents the previous column multiplied by 10.

Given the design of the frame, five beads is the smallest number with which one can count from 0 to 9. Each one of the lower beads moved toward the middle bar counts for 1, and the upper bead, when moved to the middle bar, counts for 5. Therefore each of the possible digits 0, 1, ..., 9 can be represented by a suitable positioning of the beads.

The basic operation for counting from 0 to 4 is performed by using the thumb to move one lower bead after another to the middle bar. After reaching four beads the bead on the top side of the Soroban is invoked with the index finger and moved to the dividing bar, while the four lower beads are moved back to the frame with the index finger. Now the counting can proceed with moving more beads of the first column towards the dividing bar with the thumb. After 9 has been reached, the thumb and index finger move all beads of the first column to the outer frame and the first bead of the second column is moved to the dividing bar, representing 10.

The operation of the tool starts from the right, i.e., the left hand stabilizes the tool, while the index finger and thumb of the right hand move the beads. When subtracting numbers like 6, 7, 8 and 9 from 9 the beads are simultaneously moved with thumb and index finger.

Figure 2 represents the process of counting from 1 up to 10.

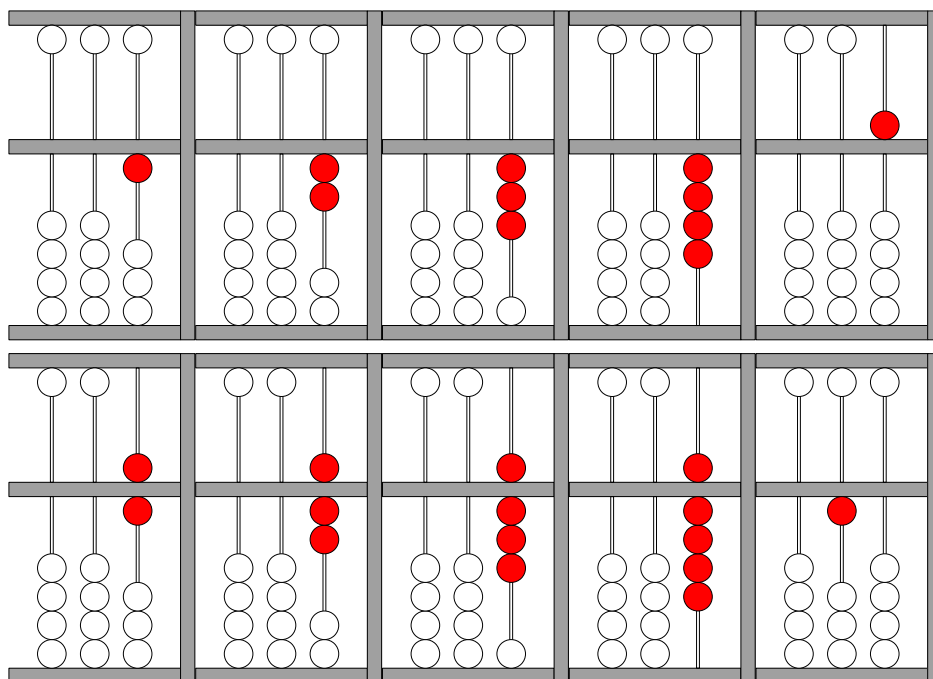


Fig. 2. Counting from 1 up to 10

5. Addition

In this section, for addition, and the next section, for subtraction, a number of tables are shown. The heading “Calculation” indicates the calculation to be performed. The “Start number” heading means the primary setup of the Soroban before the calculation takes place. The column called “Actions” shows the bead movements to reach the solution given under the heading “Result”. The last column shows the formula leading to the given result.

4+1, 4+2, 4+3, 4+4

For calculating with the Soroban it is good to remember that

$1 + 4 = 5$, $2 + 3 = 5$, $3 + 2 = 5$ and $4 + 1 = 5$.

Calculation	Start number	Actions	Result	Because:
$4 + 1$	4	+ 5 - 4	5	$4 + 5 - 4 = 5$
$4 + 2$	4	+ 5 - 3	6	$4 + 5 - 3 = 6$
$4 + 3$	4	+ 5 - 2	7	$4 + 5 - 2 = 7$
$4 + 4$	4	+ 5 - 1	8	$4 + 5 - 1 = 8$

Table 1.

As an example, $4 + 1$ is calculated on the Soroban as shown in figure 3.

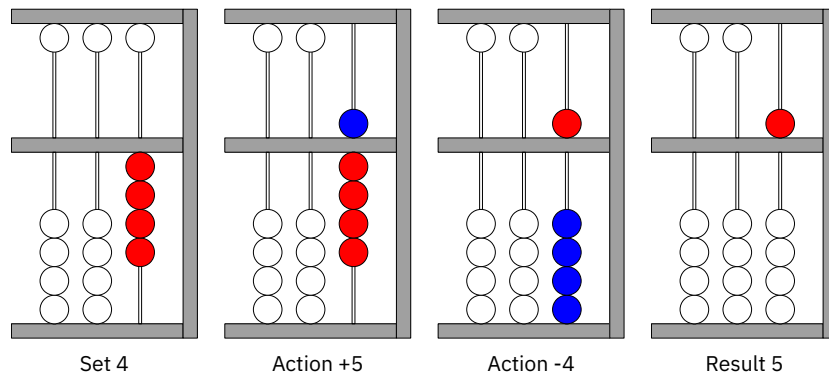


Fig. 3. Calculating 4 + 1

As can be seen in table 1, the approach for the other number combinations is similar.

4+9, 4+7, 4+6, 9+6, 8+4, 7+5

For calculating with the Soroban it is good to remember that

$1 + 9 = 10$, $2 + 8 = 10$, $3 + 7 = 10$, $4 + 6 = 10$ and $5 + 5 = 10$

Calculation	Start number	Actions	Result	Because:
4 + 9	4	+ 10 - 1	13	$4 + 10 - 1 = 13$
4 + 7	4	+ 10 - 3	11	$4 + 10 - 3 = 11$
4 + 6	4	+ 10 - 4	10	$4 + 10 - 4 = 10$
9 + 6	9	+ 10 - 4	15	$9 + 10 - 4 = 15$
8 + 4	8	+ 10 - 6	12	$8 + 10 - 6 = 12$
7 + 5	7	+ 10 - 5	12	$7 + 10 - 5 = 12$

Table 2.

The first calculation of table 2 performed on the Soroban is shown in figure 4.

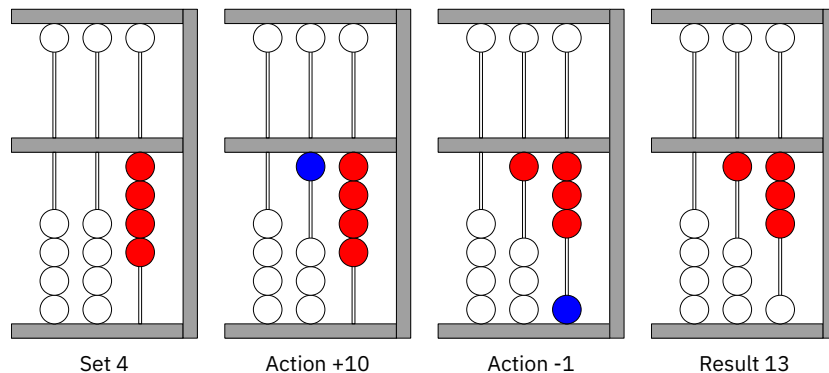


Fig. 4. Calculating 4 + 9

contextgroup > context meeting 2024

5+6, 5+9, 6+7, 6+8, 39+13, 48+6, 98+4, 99+9, 998+7

Remember:

$1 + 9 = 10$, $2 + 8 = 10$, $3 + 7 = 10$ and $4 + 6 = 10$

Calculation	Start number	Actions	Result	Because:
5 + 6	5	- 4 + 10	11	$5 - 4 + 10 = 11$
5 + 9	5	- 1 + 10	14	$5 - 1 + 10 = 14$
6 + 7	6	- 3 + 10	13	$6 - 3 + 10 = 13$
6 + 8	6	- 2 + 10	14	$6 - 2 + 10 = 14$
39 + 13	39	+ 10 - 7 + 10	52	$39 + 10 - 7 + 10 = 52$
48 + 6	48	- 4 + 10	54	$48 - 4 + 10 = 54$
98 + 4	98	- 6 + 10	102	$98 - 6 + 10 = 102$
99 + 9	99	- 1 + 10	108	$99 - 1 + 10 = 108$
998 + 7	998	- 3 + 10	1005	$998 - 3 + 10 = 1005$

Table 3.

Two examples from table 3 performed on the Soroban are shown in figures 5 and 6.

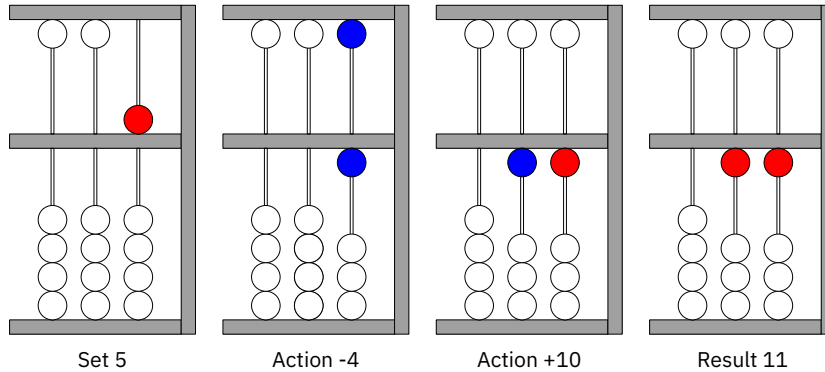


Fig. 5. Calculating 5 + 6

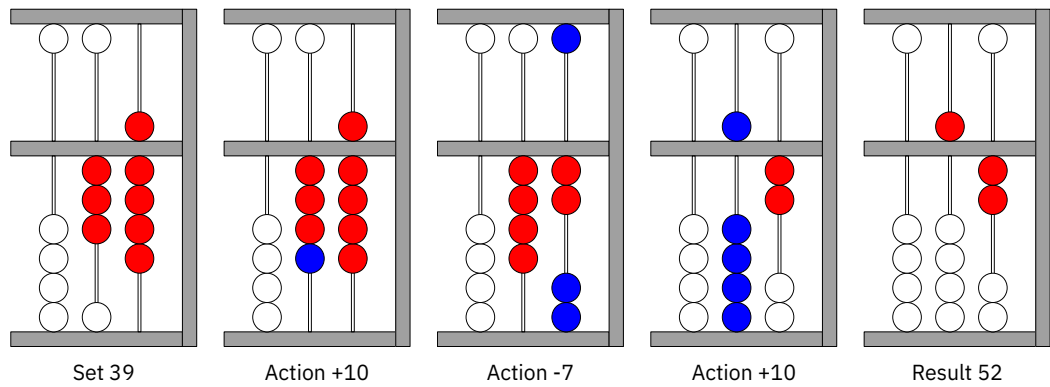


Fig. 6. Calculating $39 + 13$

6. Subtraction

5-4, 5-3, 5-2, 5-1

For calculating with the Soroban one should remember that:

$1 + 4 = 5$, $2 + 3$, $3 + 2 = 5$ and $4 + 1 = 5$

Calculation	Start number	Actions	Result	Because:
$5 - 4$	5	- 4	1	$5 - 4 = 1$
$5 - 3$	5	- 3	2	$5 - 3 = 2$
$5 - 2$	5	- 2	3	$5 - 2 = 3$
$5 - 1$	5	- 1	4	$5 - 1 = 4$

Table 4.

The first calculation in table 4 executed on the Soroban is given in figure 7.

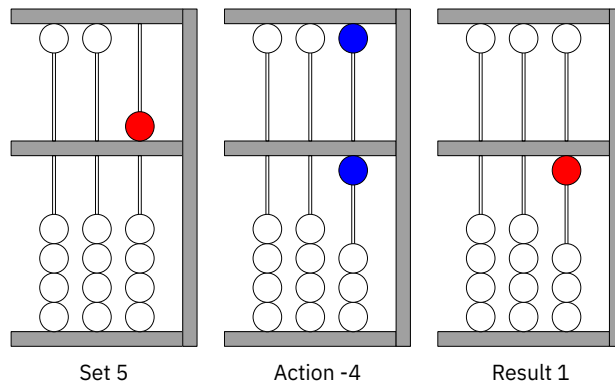


Fig. 7. Calculating $5 - 4$

10-9, 10-7, 10-4, 10-2, 11-6, 12-7, 13-8, 14-9

For calculating with the Soroban it is good to remember that
 $1 + 9 = 10$, $2 + 8 = 10$, $3 + 7 = 10$, $4 + 6 = 10$ and $5 + 5 = 10$

Calculation	Start number	Actions	Result	Because:
10 - 9	10	- 10 + 1	1	$10 - 10 + 1 = 1$
10 - 7	10	- 10 + 3	3	$10 - 10 + 3 = 3$
10 - 4	10	- 10 + 6	6	$10 - 10 + 6 = 6$
10 - 2	10	- 10 + 8	8	$10 - 10 + 8 = 8$
11 - 6	11	- 10 + 4	5	$11 - 10 + 4 = 5$
12 - 7	12	- 10 + 3	5	$12 - 10 + 3 = 5$
13 - 8	13	- 10 + 2	5	$13 - 10 + 2 = 5$
14 - 9	14	- 10 + 1	5	$14 - 10 + 1 = 5$

Table 5.

The first calculation in table 5 performed on the Soroban is presented in figure 8.

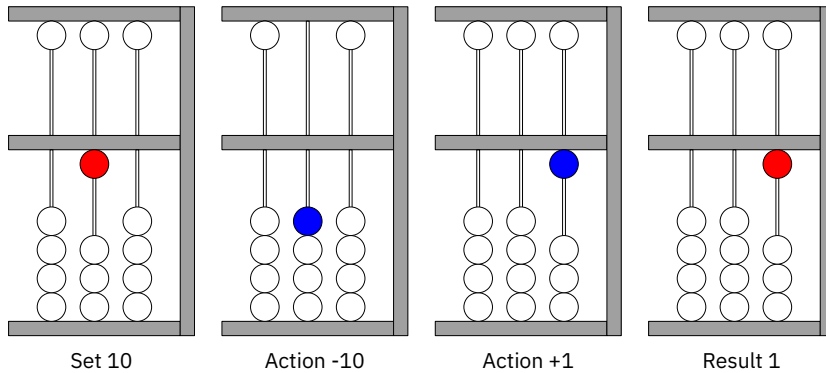


Fig. 8. Calculating 10 – 9

A second example taken from table 5: $13 - 8$, executed on the Soroban is shown in figure 9.

50-4, 51-7, 53-6, 60-11, 62-17, 100-9, 101-4, 104-7, 110-16

Remember:

$1 + 9 = 10$, $2 + 8 = 10$, $3 + 7 = 10$, $4 + 6 = 10$ and $5 + 5 = 10$

Two examples from table 6 are shown in figures 10 and 11

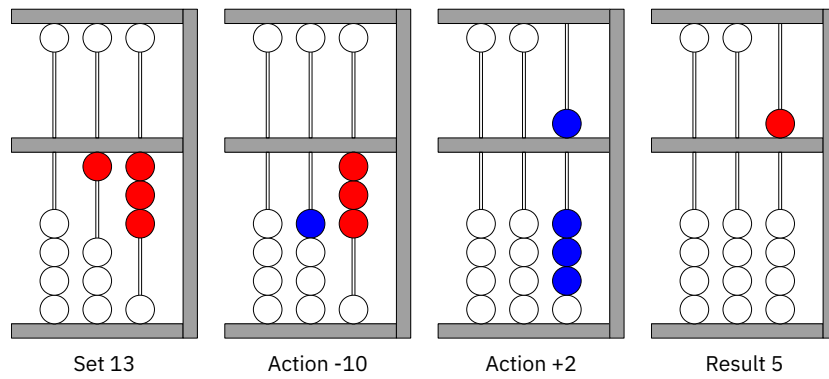


Fig. 9. Calculating 13 – 8

Calculation	Start number	Actions	Result	Because:
50 - 4	50	- 10 + 6	46	50 - 10 + 6 = 46
51 - 7	51	- 10 + 3	44	51 - 10 + 3 = 44
53 - 6	53	- 10 + 4	47	53 - 10 + 4 = 47
60 - 11	60	- 10 + 1	49	60 - 10 - 1 = 49
62 - 17	62	- 10 - 10 + 3	45	62 - 10 - 10 + 3 = 45
100 - 9	100	- 10 + 1	91	100 - 10 + 1 = 91
101 - 4	101	- 10 + 6	97	101 - 10 + 6 = 97
104 - 7	104	- 10 + 3	97	104 - 10 + 3 = 97
110 - 16	104	- 10 - 10 + 4	94	110 - 10 - 10 + 4 = 94

Table 6.

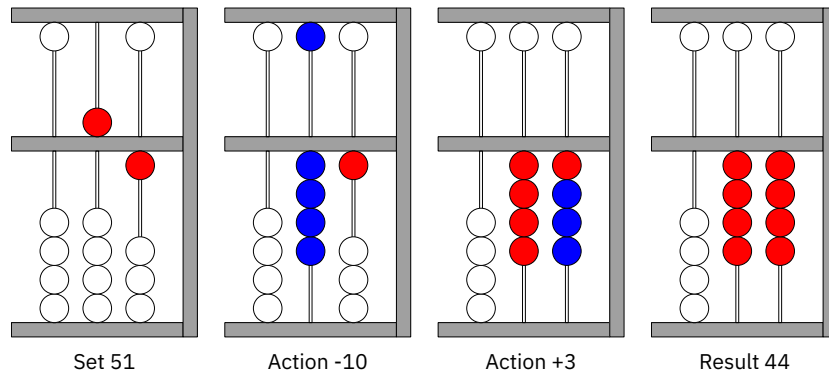


Fig. 10. Calculating 51 – 7

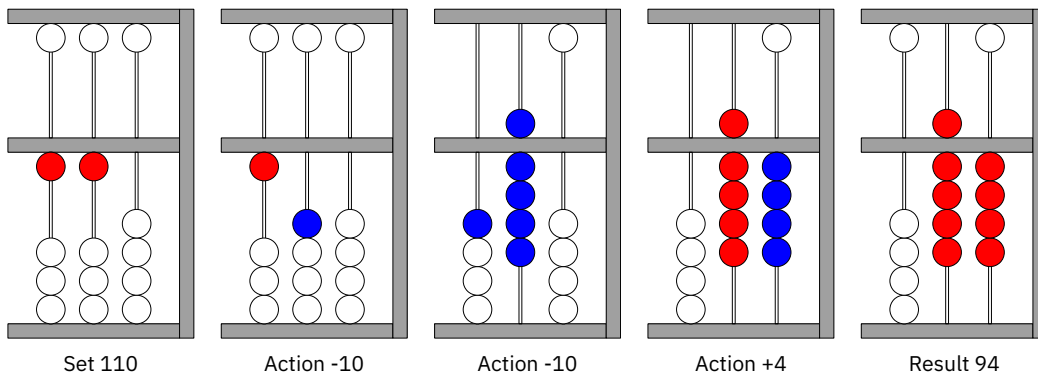


Fig. 11. Calculating $110 - 16$

7. Exercises

Now that the basic techniques of how to use the Soroban are known, here follows a series of exercises.

Simple Additions and Subtractions

1	2	3	4	5	6	7	8	9	10
20	10	30	30	40	20	40	20	30	20
10	10	10	-20	-10	10	-30	20	-10	20
10	20	-10	20	-20	-10	20	-30	20	-40

Answers:

1 2 3 4 5 6 7 8 9 10
 40 40 30 30 10 20 30 10 40 0

1	2	3	4	5	6	7	8	9	10
55	44	77	13	54	21	11	76	27	54
22	55	22	70	45	67	55	12	52	45
-66	-77	-88	-62	-86	-75	-61	-67	-59	-76

Answers:

1 2 3 4 5 6 7 8 9 10
 11 22 11 21 13 13 5 21 20 23

Addition and Subtraction

The following exercises involve the $4 + 1$, $4 + 2$, $4 + 3$, $4 + 4$ operations.

1	2	3	4	5	6	7	8	9	10
			90	80	11	70	40	20	80
10	20	30	-60	-70	32	-50	30	30	-50
40	40	40	40	40	44	30	-60	-50	30

Answers:

1 2 3 4 5 6 7 8 9 10
 50 60 70 70 50 87 50 10 0 60

1	2	3	4	5	6	7	8	9	10
302	402	401	503	304	403	453	313	240	454
203	204	104	303	201	205	232	252	610	132

Answers:

1 2 3 4 5 6 7 8 9 10
 505 606 505 806 505 608 685 565 850 586

The following exercises involve the $5 - 4$, $5 - 3$, $5 - 2$ and $5 - 1$ operations.

1	2	3	4	5	6	7	8	9	10
50	60	70	77	66	55	560	870	780	650
-40	-40	-40	-33	-33	-22	-320	-430	-340	-410

contextgroup > context meeting 2024

Answers:

1 2 3 4 5 6 7 8 9 10
10 20 30 44 33 33 240 440 440 240

1	2	3	4	5	6	7	8	9	10
556	987	867	765	556	556	566	567	576	876
-444	-444	-444	-432	-123	-221	-222	-234	-342	-432

Answers:

1 2 3 4 5 6 7 8 9 10
112 543 423 333 433 335 344 333 234 444

The following exercises involve $4 + 9$, $4 + 7$, $4 + 6$, $9 + 6$, $8 + 4$, and $7 + 5$ operations.

1	2	3	4	5	6	7	8	9	10
40	80	16	92	44	99	77	99	78	87
90	90	99	57	66	66	33	22	32	23

Answers:

1 2 3 4 5 6 7 8 9 10
130 170 115 149 110 165 110 121 110 110

1	2	3	4	5	6	7	8	9	10
76	26	38	14	82	90	23	39	99	88
44	84	24	83	33	15	64	21	11	22
-20	-10	53	24	45	15	35	40	45	94

Answers:

1 2 3 4 5 6 7 8 9 10
100 100 115 121 160 120 122 100 155 204

The following exercises involve $10 - 9$, $10 - 7$, $10 - 4$, $10 - 2$, $11 - 6$ and $12 - 7$ operations.

1	2	3	4	5	6	7	8	9	10
13	11	17	15	11	120	140	191	205	356
-9	-9	-9	-8	-8	-8	-7	-77	-77	-77

Answers:

1 2 3 4 5 6 7 8 9 10
4 2 8 7 3 112 133 114 128 279

1	2	3	4	5	6	7	8	9	10
160	209	264	211	206	260	208	264	311	216
-99	-68	-83	-77	-63	-98	-14	-83	-77	-36
-45	-58	-97	-95	-59	-84	-55	-92	-45	-91

Answers:

1 2 3 4 5 6 7 8 9 10
16 83 84 39 84 78 139 89 189 89

1	2	3	4	5	6	7	8	9	10
44	35	84	84	84					
-8	-3	-19	-58	-18	222	504	642	540	544
-9	-7	-3	-9	-7	-167	-199	-267	-386	-179

contextgroup > context meeting 2024

Answers:

1 2 3 4 5 6 7 8 9 10
27 25 62 17 59 55 305 375 154 365

The following exercises concern $5 + 6$, $5 + 9$, $6 + 7$, $6 + 8$, $39 + 13$, $48 + 6$,
 $98 + 4$, $99 + 9$ and $998 + 7$.

1	2	3	4	5	6	7	8	9	10
15	125	250	203	301	12	200	320	120	210
6	6	6	7	7	70	9	92	99	94

Answers:

1 2 3 4 5 6 7 8 9 10
121 122 123 125 126 222 123 245 314 345

1	2	3	4	5	6	7	8	9	10
15	125	250	203	301	12	200	320	120	210
-6	-6	-60	-44	-44	-3	-11	-111	-111	-91

Answers:

1 2 3 4 5 6 7 8 9 10
9 119 190 159 257 9 189 209 9 119

1	2	3	4	5	6	7	8	9	10
160	209	264	211	206	260	208	264	311	216
-99	-68	-83	-77	-63	-98	-14	-83	-77	-36
-45	-58	-97	-95	-59	-84	-55	-92	-45	-91

Answers:

1 2 3 4 5 6 7 8 9 10
16 83 84 39 84 78 139 89 189 89

1	2	3	4	5	6	7	8	9	10
44	35	84	84	84					
-8	-3	-19	-58	-18	222	504	642	540	544
-9	-7	-3	-9	-7	-167	-199	-267	-386	-179

Answers:

1 2 3 4 5 6 7 8 9 10
27 25 62 17 59 55 305 375 154 365

1	2	3	4	5	6	7	8	9	10
			41	45	46	37	16	13	34
34	37	35	9	6	9	15	36	23	12
17	17	16	5	9	5	18	19	18	6

Answers:

1 2 3 4 5 6 7 8 9 10
51 54 51 55 60 60 70 71 54 52

1	2	3	4	5	6	7	8	9	10
			83	75	78	76	84	57	67
89	89	79	14	17	19	29	18	46	36
11	12	22	3	9	7	-34	-27	-28	-48

Answers:

1 2 3 4 5 6 7 8 9 10
100 101 101 100 101 104 71 75 75 55

contextgroup > context meeting 2024

The following exercises involve $50 - 4$, $51 - 7$, $53 - 6$, $60 - 11$, $62 - 17$, $100 - 9$, $101 - 4$, $104 - 7$ and $110 - 16$ operations.

1	2	3	4	5	6	7	8	9	10
			57	74	20	36	57	81	92
51	52	53	-9	-20	40	35	38	-26	-27
-7	-5	-6	53	-6	-11	-28	-46	-9	-18

Answers:

1 2 3 4 5 6 7 8 9 10
44 47 47 101 48 49 43 49 46 47

1	2	3	4	5	6	7	8	9	10
50	48	37	103	104	50	24	68	124	134
50	52	63	-4	-8	60	88	44	-6	-27
-1	-3	-5	5	6	-11	-14	-16	-19	-8

Answers:

1 2 3 4 5 6 7 8 9 10
99 97 95 104 102 99 98 96 99 99

8. Acknowledgment

The given information is thanks to the instruction manual “How to use a Soroban, Japanese abacus” from the Japanese Soroban manufacturer Tomoe Soroban Co., Ltd. The instructions and exercises given are published with permission of the manufacturer for which they have my sincerest thanks.

9. Source

How to use a Soroban, Japanese abacus. Tomoe Soroban Co., Ltd, 1-10, Wakaba, Shinjuku-ku, Tokyo 160-0011, www.soroban.com.