

Soroban

The Japanese Abacus
By Kimie Markarian

算盤

Japan 21 has class sets of soroban and teaching soroban available for loan; please contact us on 020 7630 8696 or education@japan21.org.uk

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National Curriculum Links

KS2 Mathematics

Ma2: Number

1c) Pupils will select and use appropriate mathematical equipment (in this case the soroban) to help them find the solution to problem.

2i) Pupils will understand and use decimal notation with regard to money and use the soroban to help with calculations.

3k) Pupils will use a soroban for calculations involving several digits, including decimals and know how to select the correct sequence for calculations.

Soroban is the name of the Japanese abacus, used for 450 years, since its arrival in Japan from China in the middle of the 16th century. Over time, the structure of the abacus has been refined to its present form (see illustration), which has been in general use since 1938.

In Japan, the art of using the soroban has been carefully cultivated: in 1928, soroban examinations were established by the Japanese Chamber of Commerce and Industry, with more than a million candidates sitting the tests by 1959. Although complex calculations are now carried out by computers, the soroban is still in use in some offices and shops, alongside computers and electronic calculators.

When used by an expert, the soroban is capable of difficult calculations, but at a more basic level it can also be a useful tool in general mathematics education. It enables figures to be represented in a concrete visual way, which can help pupils' grasp of numbers, particularly in understanding place value and in overcoming problems arising from the irregular construction of number words in the '-teens' and '-tys'.

Soroban can be used effectively in whole class teaching: where schools do not have access to a large teaching soroban, a soroban frame drawn on an OHP transparency can substitute. Japan 21 has a class set of soroban and a teaching soroban available for loan, please contact us on 020 7630 8696 or education@japan21.org.uk if you wish to borrow them.

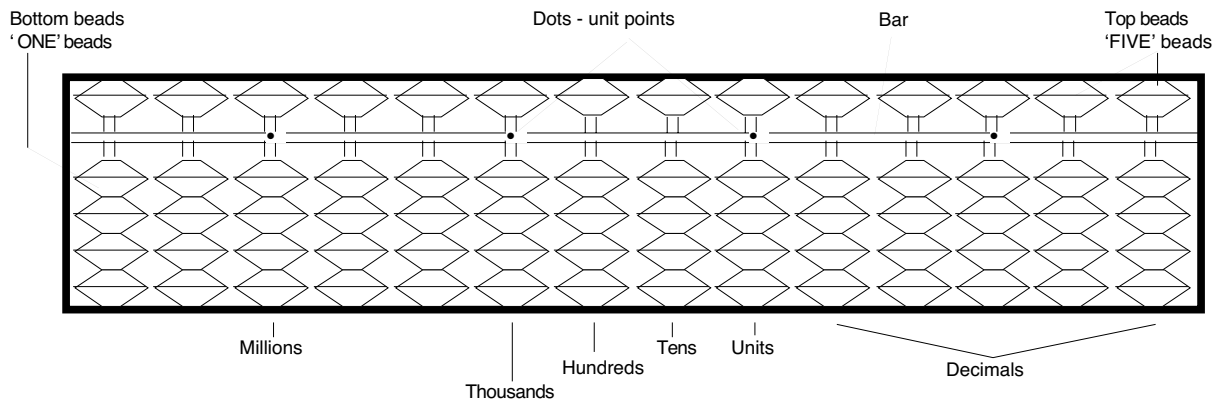
There are certain conventions connected with soroban use which may be introduced to create a distinctive working atmosphere. In traditional soroban classes, the teacher will often read out a string of numbers which the students calculate on their soroban. When the correct answer is given all those who have the same answer say "go-meisan" ("that's right"). This kind of oral exercise requires concentration and can improve listening ability. Achieving the correct answer may also increase motivation.

Pupils are asked to hold the soroban steady with their left hand, hold a pencil ready with the second, third and fourth fingers of the right hand and use the right thumb and forefinger to move the soroban beads. Left-handed pupils may work in reverse.

Before beginning, the soroban is "cleared" by:

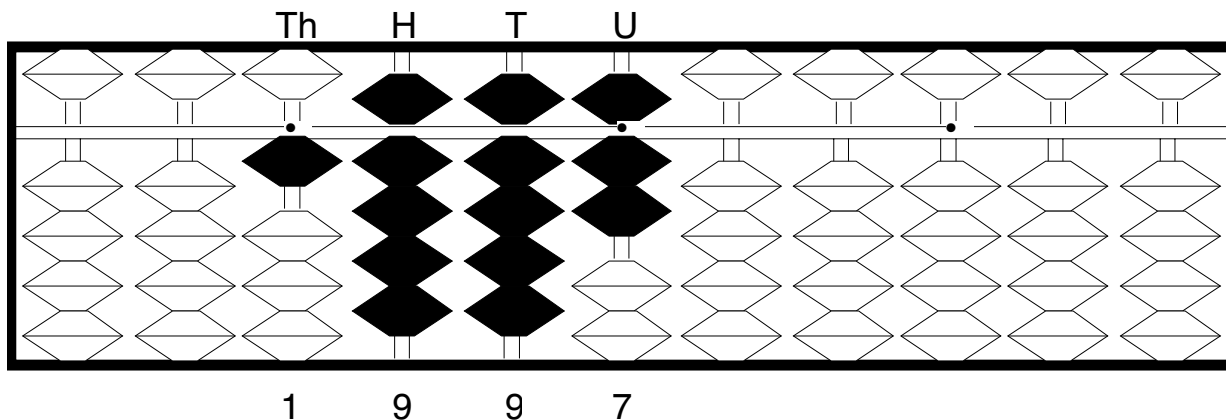
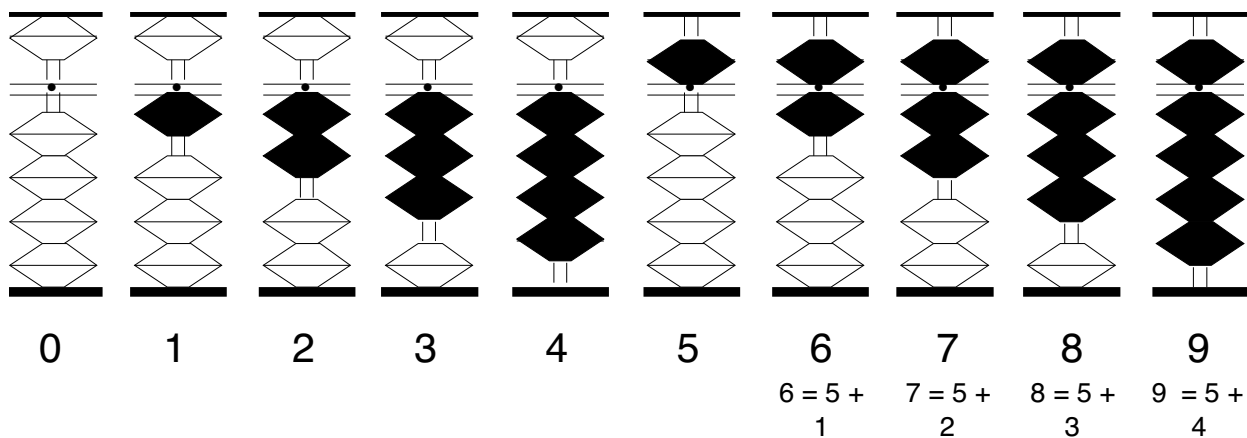
1. tilting it up towards you with the left hand, so all the beads drop down.
2. gently laying it flat on the table.
3. running the right forefinger along the bar to push the 'five' beads to the top.

With no beads touching the bar the soroban now reads 'zero'. Beads are only counted when they touch the bar.



This soroban reads 'zero'

The illustrations show how to display the numbers 1-9. Note how numbers 6-9 are all shown with a combination of one "five" bead and "one" beads. The same principle applies to the tens, hundreds, thousands columns.



When practicing setting numbers on the soroban it can be fun to use numbers with some significance, for example the year, as shown here, or perhaps the number of pupils in the class, days in the year or even numbers on a Japanese theme, such as the height of Mount Fuji, the population of Japan.

Beads are moved in the following way:

bottom beads: (ones)

- upwards (towards the bar) - with thumb
- downward (away from the bar) - with forefinger

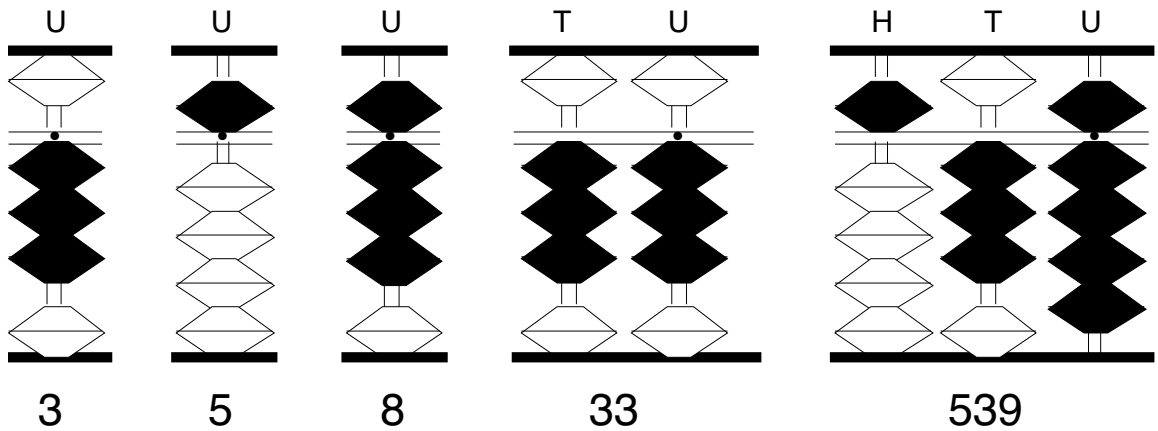
top beads: (fives)

- upwards (away from the bar) } both with forefinger
- downward (towards the bar) }

When both top and bottom beads are required simultaneously, they are 'pinched' between thumb and forefinger. eg to set numbers 6 - 9.

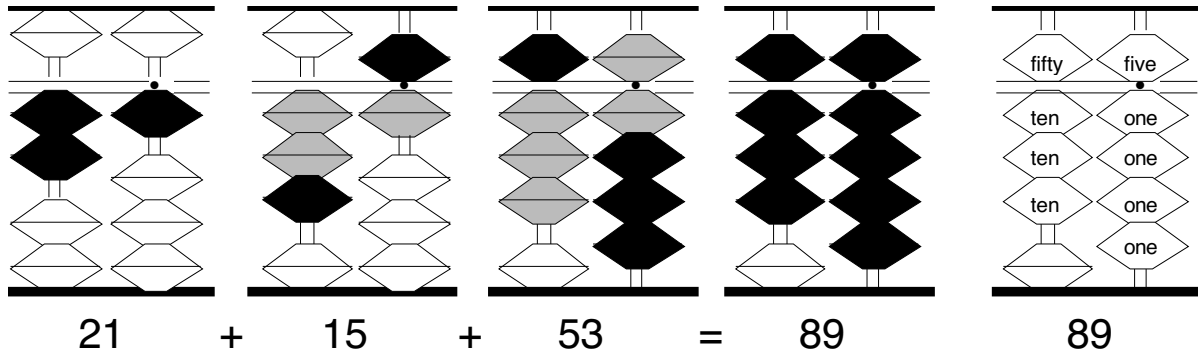
Simple Activities

- Using a large teaching soroban or a soroban frame on an OHP, ask pupils to read off numbers, for example:

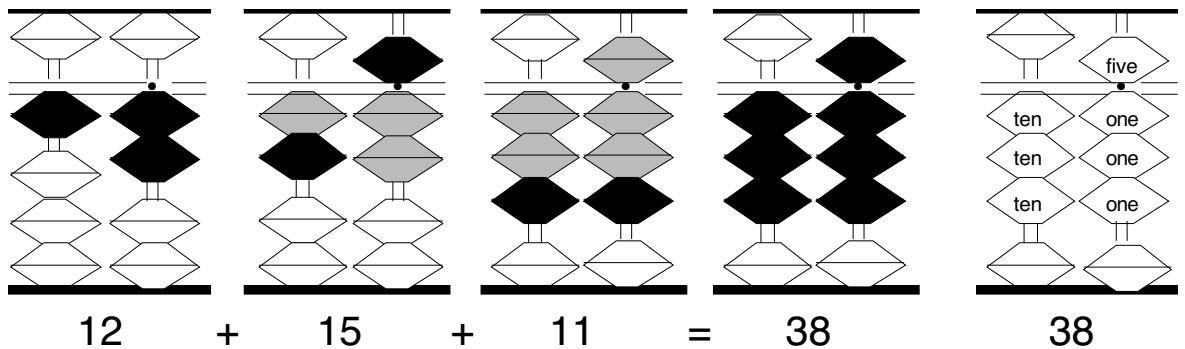


- Ask pupils to set numbers themselves (as above).
- Ask pupils to add / subtract numbers and read off the answer
eg. $21 + 15 + 53 = 89$

(At this stage, be careful to choose numbers which, when added, do not require pupils to work in number bonds 5 or 10. This is not difficult, but could cause confusion in the early stages.)



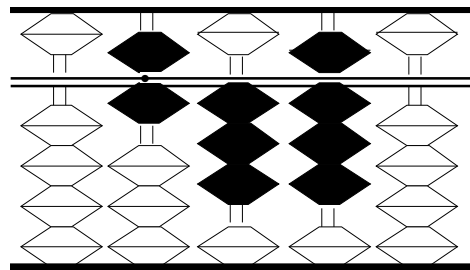
Simple sums can be used to reinforce irregular numbers eg twelve + fifteen + eleven = 38



4. Soroban can also be used to teach how to calculate in simple shopping situations.
 payment - cost = change

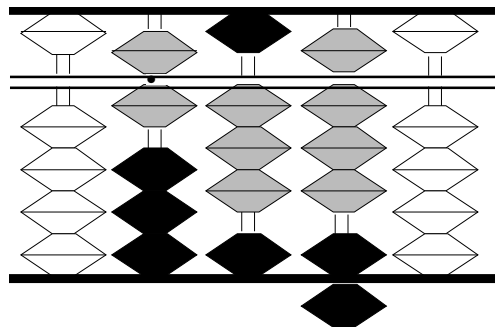
You buy two things at a cost of £5.13 and £1.25 and you pay with a £10.00 note.
 How much change should you get?

a) You add £5.13 to £1.25 with a soroban, which equals £6.38 (nb here units = £, decimals = p)



$$£5.13 + £1.25 = £6.38$$

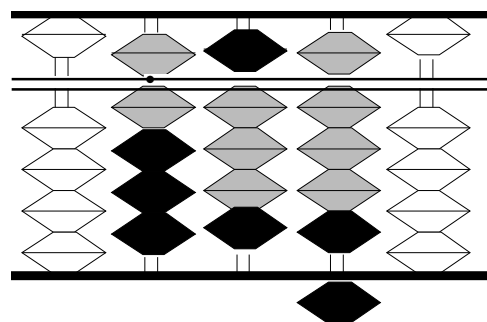
b) You calculate the change by adding '0.01' to the unmoved beads '3.61', which will equal 3.62. 3.62 is the difference between the cost of you purchases and the amount tendered (£10.00).



$$£10.00 - £6.38 = £3.62$$

c) Add the change (£3.62) to the price (£6.38) and you will get £10.00

d) If you visualise soroban beads in your head it can help you check change when out shopping.



$$£3.62 + £6.38 = £10.00$$

How do you calculate on the soroban frame?

Remember there is one bead above the horizontal line and four below.

Addition: Draw beads to represent the first number then add beads to represent the number to be added.

Subtraction: Draw beads to represent the first number then, to subtract, strike through the beads representing the number to be subtracted.

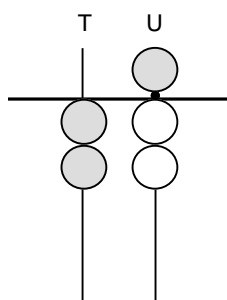
It is important to plan exercises carefully in advance. Soroban can give pupils useful practice in working with number bonds 5 and 10 but it is best to ensure they are competent with basic calculations before moving on. Examples of different procedures are given here.

Straightforward calculation

A) $25+2=27$

1. +25

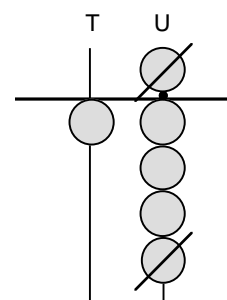
2. +2



S) $19-6=13$

1. +19

2. -6



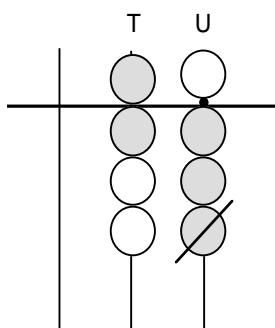
Calculation involving knowledge of number bond 5

A) $63+24=87$

1. +63

2. +20

3. +4 i.e.(+5-1)

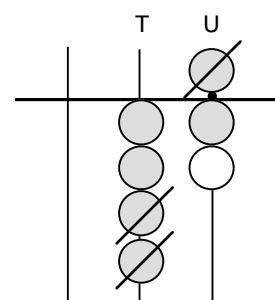


S) $46-24=22$

1. +46

2. -20

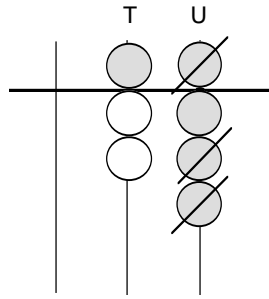
3. -4 i.e.(-5+1)



Calculation involving knowledge of number bond 10

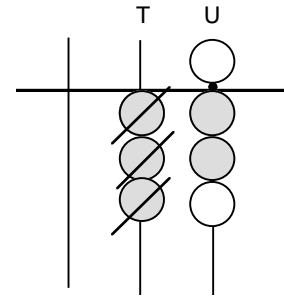
A) $58+13=71$

1. +58
2. +10
3. +3 i.e.(+10-7)



S) $32-24=8$

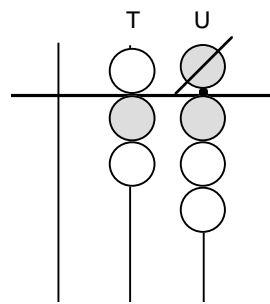
1. +32
2. -20
3. -4 i.e.(-10+6)



Calculation involving knowledge of both number bond 5 and 10

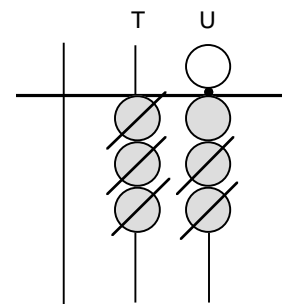
A) $16+57=73$

1. +16
2. +50
3. +7 i.e.(+10-3)
where $-3=(-5+2)$



S) $33-27=6$

1. +33
2. -20
3. -7 i.e.(-10+3)
where $+3=(+5-2)$



Addition on the soroban frame

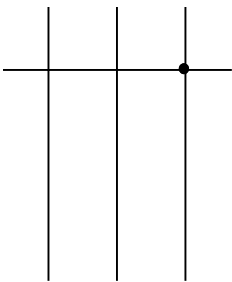
Remember there is one bead above the horizontal line and four below.

Find the answer to the following exercises by using the soroban frame. This sheet includes simple calculations (1, 2), practice with number bond 5 (3, 4), practice with number bond 10 (5 to 7), and practice with both number bonds 5 and 10 (8,9).

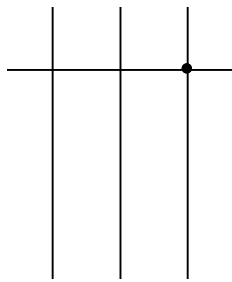
Draw beads to represent the first number then add beads to represent the number to be added. To take off beads, cross them out, don't use a rubber.

Number 6 to 9 are expressed as: $6=5$ plus 1, $7=5$ plus 2, $8=5$ plus 3, and $9=5$ plus 4.

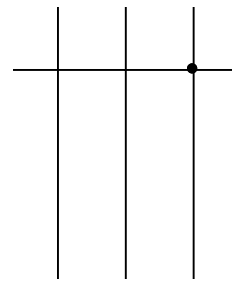
1) $52+36=$



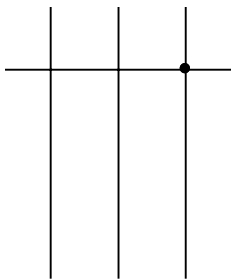
2) $123+506=$



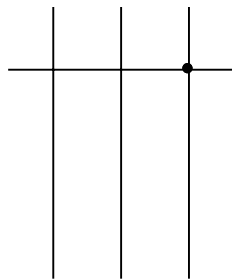
3) $63+24=$



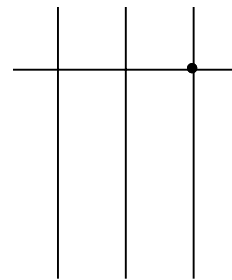
4) $34+140=$



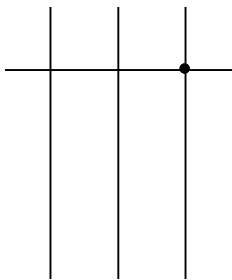
5) $354+28=$



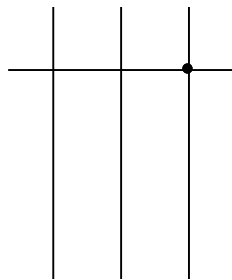
6) $180+52=$



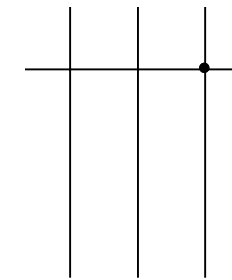
7) $106+28=$



8) $52+84=$



9) $126+418=$



Addition & Subtraction on the soroban frame

Remember there is one bead above the horizontal line and four below.

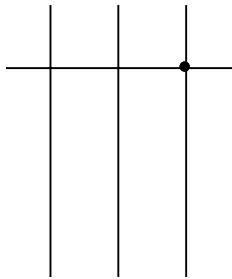
Find the answer to the following exercises by using the soroban frame.

To take off beads, cross them out strike it through. Don't use a rubber.

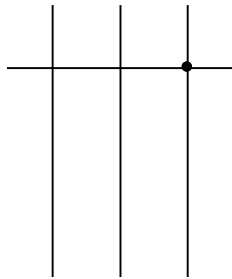
Numbers 6 to 9 are expressed as: $6=5$ plus 1, $7=5$ plus 2, $8=5$ plus 3, and $9=5$ plus 4.

Nb. Exercises include practise of number bond 5, 10 and both 5 and 10.

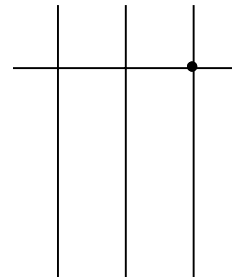
1) $152+27=$



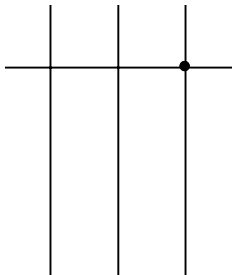
2) $389-128=$



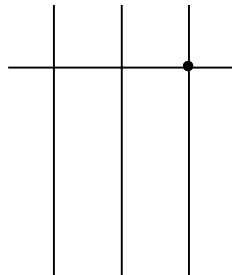
3) $23+42=$



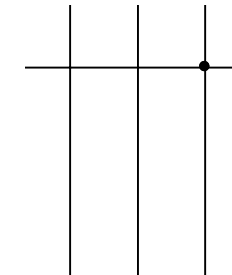
4) $56-14=$



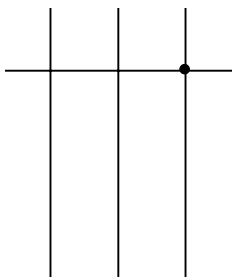
5) $172+56=$



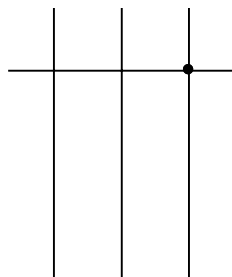
6) $263-59=$



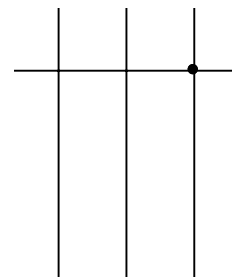
7) $106-67=$



8) $152+85=$



9) $126-74=$



Exercises for Key Stages 1, 2 and 3

Once you have explained how to calculate on the soroban frame, you can choose the appropriate exercises according to their ability.

Students can draw their answers on a sheet of soroban frames.

Three sets of questions are given. In each case:

Step 1 is simple addition on each column

Step 2 uses number bond 5

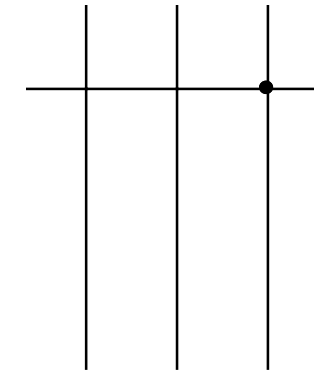
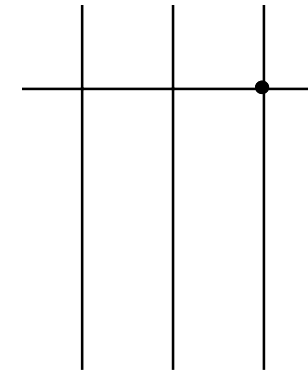
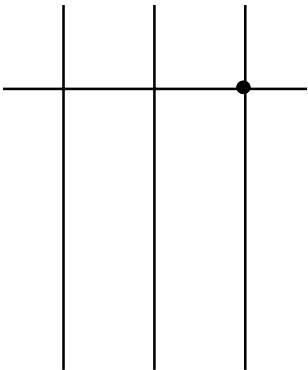
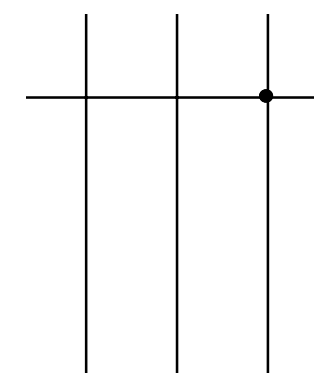
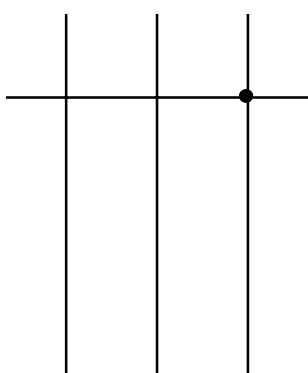
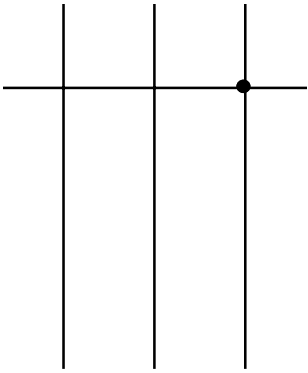
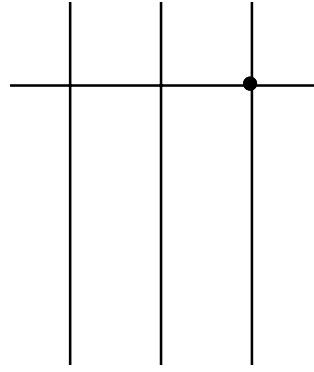
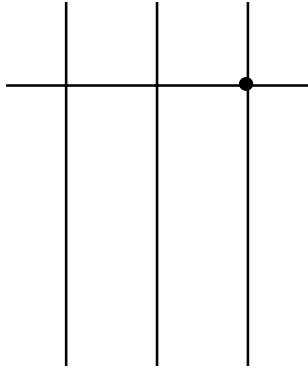
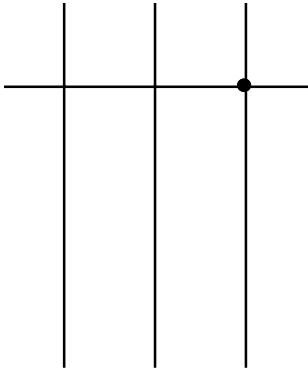
Step 3 uses number bond 10

Step 4 uses number bonds 5 and 10

No. 1	Key Stage 1	Key Stage 2	Key Stage 3
Step 1	1) $21+3=$	1) $21+53=$	1) $132+67=$
	2) $43-12=$	2) $328-206=$	2) $3859-1356=$
Step 2	3) $24+3=$	3) $215+42=$	3) $142+34=$
	4) $16-4=$	4) $67-43=$	4) $537-214=$
Step 3	5) $28+5=$	5) $83+9=$	5) $36+55=$
	6) $25-6=$	6) $82-55=$	6) $143-54=$
Step 4	7) $37+6=$	7) $36+57=$	7) $265+576=$
	8) $23-8=$	8) $73-56=$	8) $624-568=$
No. 2			
Step 1	1) $38+50=$	1) $23+55=$	1) $102+356=$
	2) $48-6=$	2) $49-25=$	2) $333-102=$
Step 2	3) $42+30=$	3) $320+426=$	3) $341+434=$
	4) $26-2=$	4) $68-34=$	4) $546-444=$
Step 3	5) $72+9=$	5) $38+59=$	5) $327+558=$
	6) $83-5=$	6) $84-55=$	6) $432-295=$
Step 4	7) $27+6=$	7) $26+18=$	7) $163+74=$
	8) $42-7=$	8) $32-6=$	8) $231-68=$

No. 3			
Step 1	1) $21+60=$	1) $66+23=$	1) $183+605=$
	2) $43-20=$	2) $84-52=$	2) $296-151=$
Step 2	3) $13+40=$	3) $32+43=$	3) $321+431=$
	4) $63-41=$	4) $76-34=$	4) $556-432=$
Step 3	5) $24+8=$	5) $58+37=$	5) $284+957=$
	6) $42-5=$	6) $42-28=$	6) $345-156=$
Step 4	7) $16+7=$	7) $65+76=$	7) $546+760=$
	8) $23-6=$	8) $34-18=$	8) $323-168=$

Soroban Worksheet




colour the number in beads below

Class _____

Name _____

Example	①	②	③	④
12	30	3	84	60
⑤	⑥	⑦	⑧	⑨
15	50	7	40	3
⑩	⑪	⑫	⑬	⑭
28	80	96	81	5
⑮	⑯	⑰	⑱	⑲
61	20	9	16	31

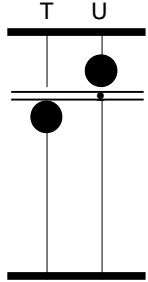
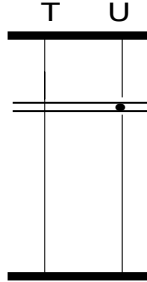
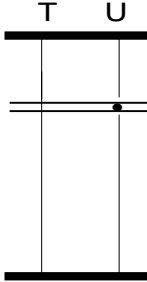
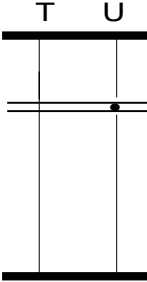
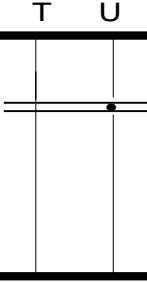
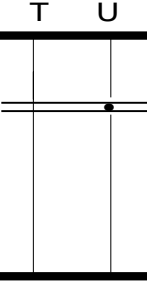
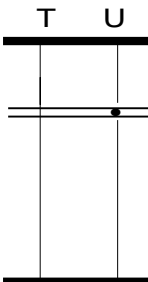
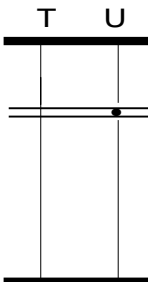
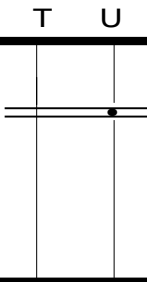
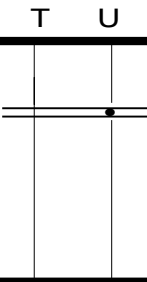
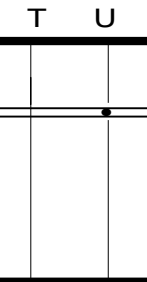
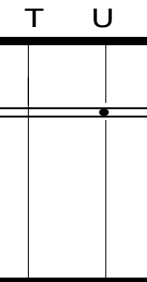
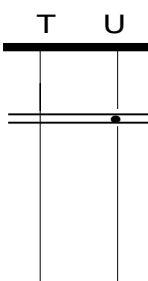
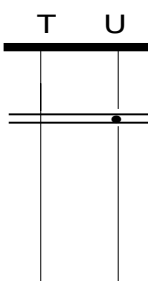
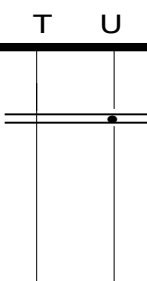
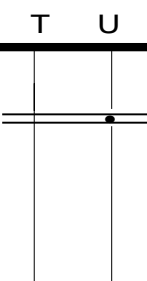
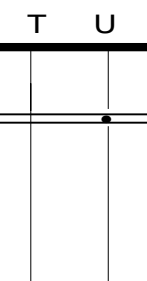
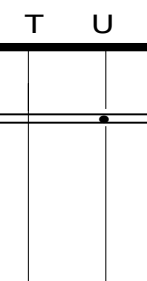
Note: soroban beads normally look like this. 
Here we have used circles, which are easier to colour in.


show the numbers on the soroban

Class _____

Name _____

Use circles to show the numbers on the soroban.

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

Note: soroban beads normally look like this. 
But for this exercise, it is easier to draw circles.

complementary numbers: 100

How much more do you need to add to make 100?

e.g.. $100=12+88$	1. $100=34+$	2. $100=16+$	3. $100=96+$
4. $100=84+$	5. $100=28+$	6. $100=66+$	7. $100=3+$
8. $100=25+$	9. $100=71+$	10. $100=42+$	11. $100=80+$
12. $100=37+$	13. $100=83+$	14. $100=19+$	15. $100=45+$

100 on the soroban is represented by one bead in the hundreds column (not seen here). Using just the tens and units columns, we can show numbers up to 99. When 1 is added, the tens and units columns are cleared and 1 bead moved in the hundreds column.

By reading the soroban pictured, then adding the total of the beads that are not being used and finally adding 1, pupils can make 100. In the example, the soroban reads '12'. The remaining beads read '87', so $100 = 12 + (87+1)$; $100 = 12 + 88$.

image creation using an OHP

Teachers Notes

There are many ways of introducing mental calculation using images of the soroban. If you have never seen a particular image, then it is hard to picture it in your mind. You can't imagine someone's face if you have never seen the person, or at least a picture of the person, before.




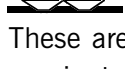
In order to visualise soroban beads, you need to look at them closely and have an idea of how the soroban works. Before starting this exercise using OHP, it is helpful if children have seen a soroban. However, you can also demonstrate its operation by drawing on a whiteboard and adding / subtracting simple numbers.

Once children have an idea of what a soroban is, you can move on to mental calculation by asking children to 'imagine' a number on a mental soroban and manipulate it. In the early stages it may be helpful to show the starter number on a soroban as an OHT. The following exercises are designed for this kind of class-based activity.

Teen numbers are particularly difficult for British children to visualise because they don't sound like the combination they come from; e.g. 'eleven' does not sound like 'ten and one'. Therefore it is necessary to practice these numbers more frequently when doing oral exercises.

Stage 1: Basic mental calculation with one additional number

- 1) Put the OHT with the starter numbers onto the OHP so that the whole class can see it.
 - 2) Ask the class, 'What number can you see under number 1?'
 - 3) The class should say the number that they can see.
 - 4) Then say, 'That's right. Now add / subtract _____ (e.g. a single or two-digit number).'
- Be careful to choose only numbers that do not require knowledge of number bonds 5 or 10.
e.g. If the starter number is 16, you can **add** the following numbers:

T U		
	1, 2, 3	10, 11, 12, 13,
	20, 21, 22, 23	30, 31, 32, 33
	50, 51, 52, 53	60, 61, 62, 63
	70, 71, 72, 73	80, 81, 82, 83

These are the ONLY numbers you can add at the basic level. Any other number, e.g. 40, would require too much mental movement of beads for beginners.

For **subtraction**, you could only use the following numbers: 1, 5, 6, 10, 11, 15, 16

Note: If you are unsure as to which numbers to use for exercises, it is best to prepare the questions in advance. Once you become more confident, you will be able to make them up as you go along. This applies to all stages.

- 5) Ask them for the answer.

image creation using an OHP

Stage 2: Basic mental calculation with two additional numbers

When children understand the basic principle and are able to add / subtract without much difficulty, you can get them to add / subtract 2 numbers from the number shown on the OHT before giving the final answer. Again, choose numbers that do not require too much mental bead movement.

e.g. the following 2 number combinations could be added/subtracted to the example 16:

$$16 + 1 + 2$$

$$16 + 22 + 1$$

$$16 + 71 + 12$$

$$16 - 5 - 1$$

$$16 - 10 - 5$$

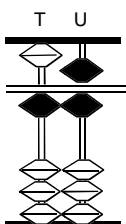
$$16 - 5 - 11$$

Stage 3: Basic mental calculation with more than 2-digit numbers

Use the same principle as described in Stages 1 & 2 with up to 4-digit numbers. Practicing 4-digit numbers is very important for everyday use e.g. when using money £24.32. Make OHTs in advance similar to the sample, this time using 3- and 4-digit numbers.

Stage 4: Number bond 5

Now you can choose numbers that require a bit more mental bead movement. Start with adding / subtracting only one number that requires the ability to calculate with number bond 5. Staying with our example '16', here are some possible sums:



Addition: 40, 41, 42, 43

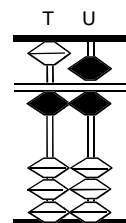
Subtraction: 2, 3, 4, 12, 13, 14

Other numbers are also possible e.g. add 51, but they do not require number bond 5

Again, you can make the exercises more complex by adding or subtracting 2 numbers before asking for an answer, or by expanding the number of digits to 4.

Stage 5: Number bond 10

Now you can choose numbers that exclusively require knowledge of number bond 10. Staying with our example '16', here are some possible sums:



Addition: 4, 5, 9, 15, 19, 25, 29, 55, 59, 65, 69, 75, 79

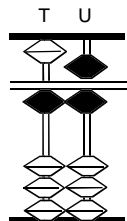
Subtraction: 7, 8, 9

Again, you can make the exercises more complex by adding or subtracting 2 numbers before asking for an answer, or by expanding the number of digits to 4

image creation using an OHP

Stage 6: Number bonds 5 and 10

Here you can choose almost any combination of numbers. If you only want to use numbers requiring the use of both number bonds 5 and 10, then here are some examples.



Addition: 6, 7, 8, 35, 36, 37, 38, 44, 45, 46, 47, 48, 49, 54, 55, 56, 57, 58, 66, 67, 68, 76, 77, 78

Subtraction: for this example, there is no number that requires knowledge of both number bonds 5 and 10.

Again, you can make the exercises more complicated by adding or subtracting 2 numbers before asking for the answer, or by expanding the number of digits to 4.

Exercises to practice making questions for pupils

Use the soroban drawings below and do the 4 exercises for each.

Exercise 1:

Which numbers can be added / subtracted to the numbers shown for Stages 1 - 3 (i.e. no knowledge of number bonds required)?

Exercise 2

Which numbers can be added / subtracted to the numbers shown for Stage 4 (i.e. knowledge of number bond 5 required)?

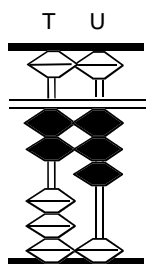
Exercise 3

Which numbers can be added / subtracted to the numbers shown for Stage 5 (i.e. knowledge of number bond 10 required)?

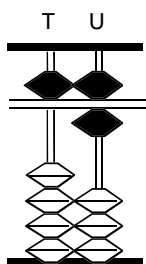
Exercise 4

Which numbers can be added / subtracted to the numbers shown for Stage 6 (i.e. knowledge of both number bond 5 AND 10 required)?

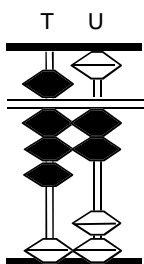
a)



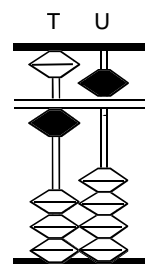
b)

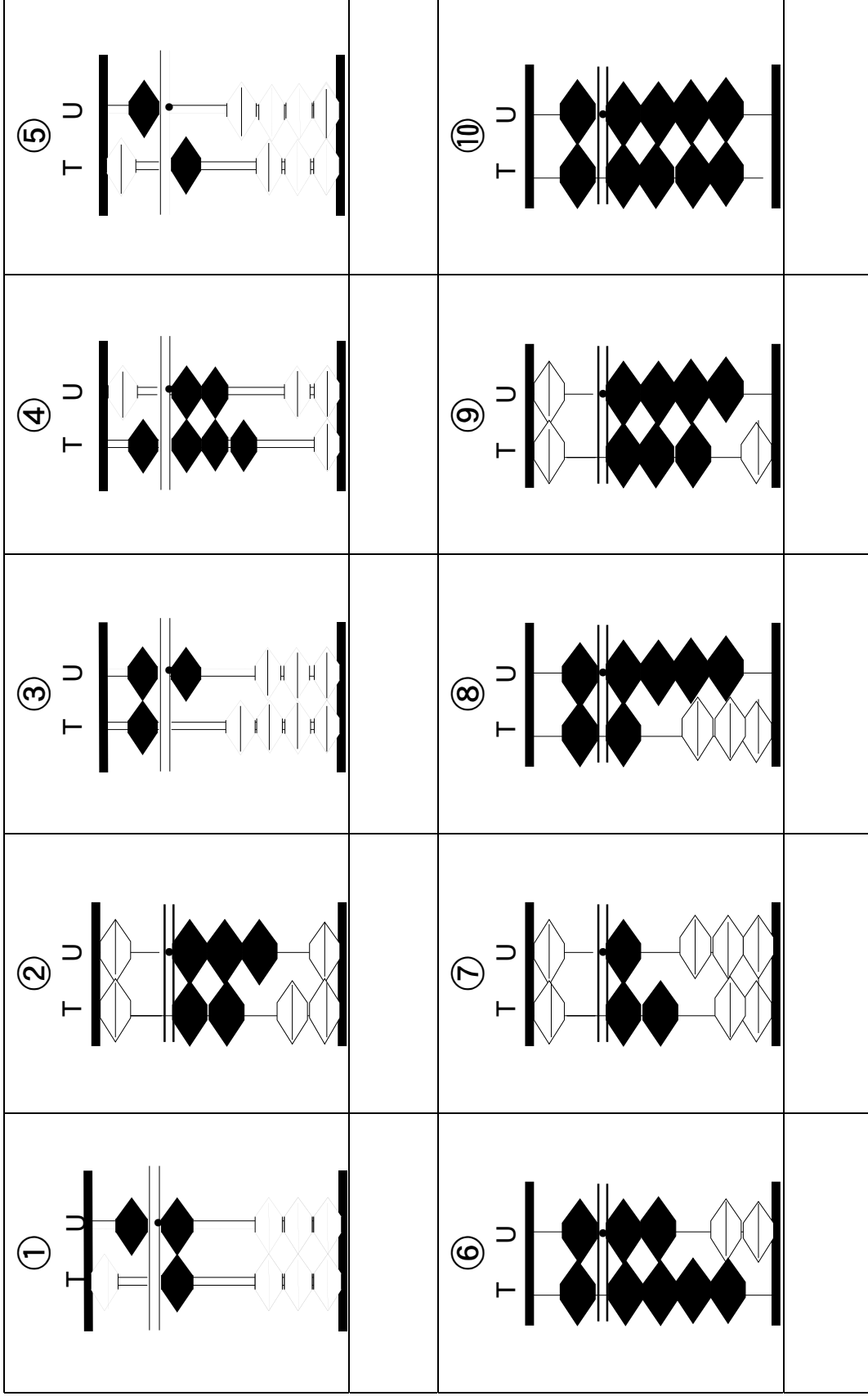


c)



d)





let's read the soroban

Notes for teachers

- 1) Ask the pupils to write in arabic form the numbers shown on the soroban frames.

Encourage them to write from left to right.
E.g. Thousands, hundreds, tens and units.

These numbers are all related to Japan:

- 3776 The height (in metres) of Japan's highest mountain, Fuji.
- 4 Japan consists of four main islands and many tiny islands.
- 11 The shortest flight takes 11 hours from Heathrow to Tokyo airport.
- 80 There are 80 active volcanoes in Japan.
- 127 Japan's population is approximately 127 million.
- 300 The fastest shinkansen (bullet train) runs at 300km/hr.
- 1868 The year the capital of Japan was named Tokyo.
- 2000 Japanese children must learn 2000 kanji symbols before the age of 15.

- 2) Ask the pupils to draw in bead form the numbers shown below the soroban frame, as in the example.

These numbers are all related to Great Britain:

- 3 (number of) main political parties.
- 18 (age) legally an adult (e.g. vote)
- 58 (million) population of Great Britain.
- 1066 (year) Battle of Hastings
- 1344 (metres) Ben Nevis – highest mountain in UK.
- 1953 (year) Queen Elizabeth came to the throne.
- 1966 (year) England won the World Cup.
- 2003 (year) England won the World Cup again (rugby)

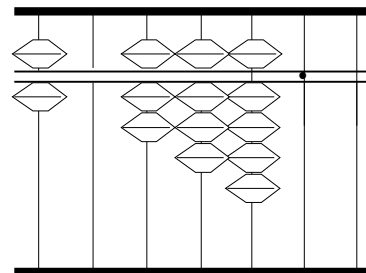
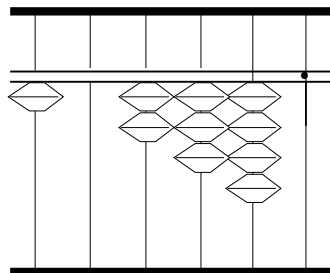
- 3) Firstly, ask the pupils to write their own telephone number and date of birth. Then ask them to draw them onto the soroban frame in the space provided.

If the telephone number contains a 0, then that column should remain blank, but if there is 0 at the end of the number, then draw a unit dot in its place, like this:

Tel: 102340

or

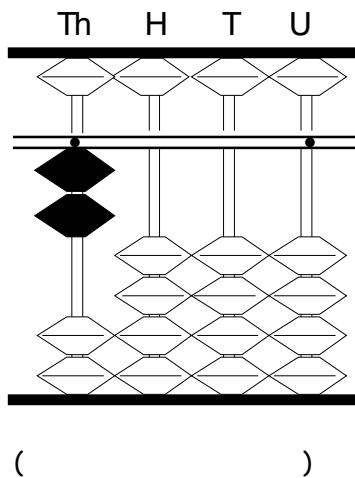
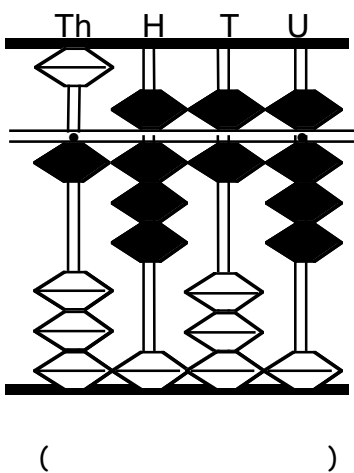
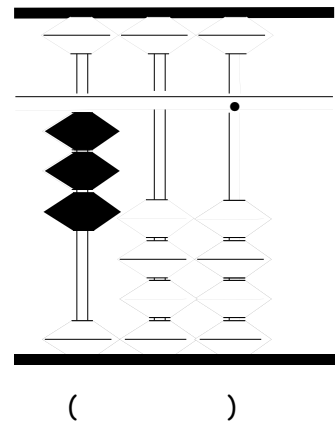
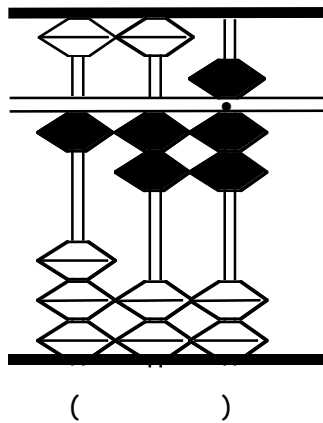
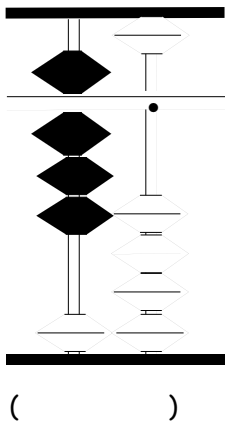
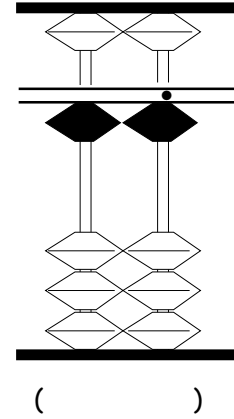
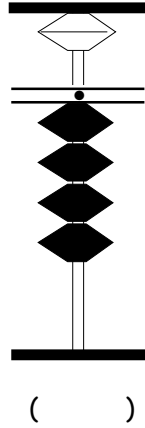
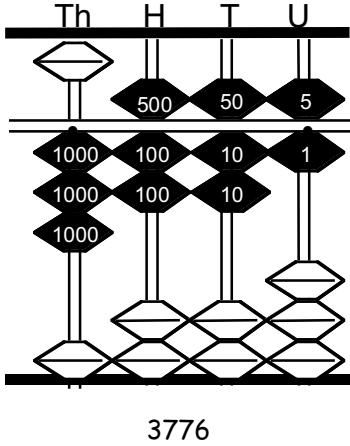
Tel: 607890




let's read the soroban

Write the correct number under each picture:

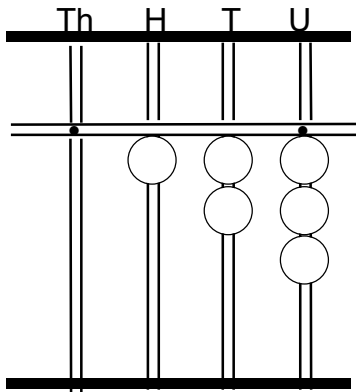
Example



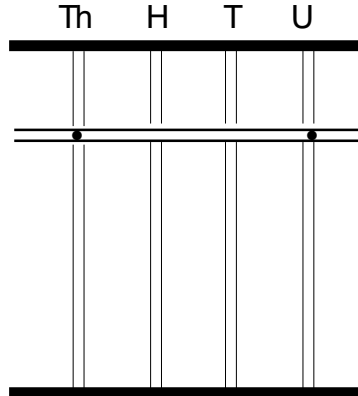
let's read the soroban

Draw soroban beads to show the number under each frame. (Soroban beads normally look like this: , but for this exercise it is easier to draw circles.)

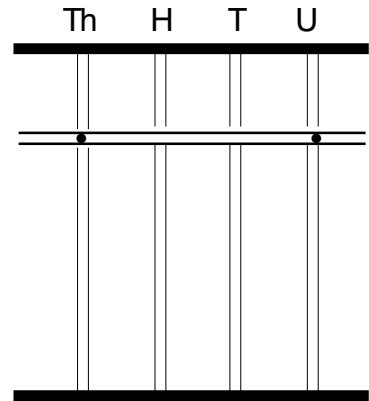
Example



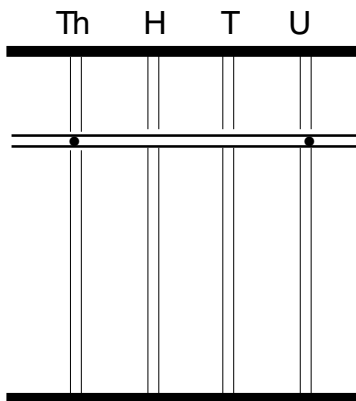
(123)



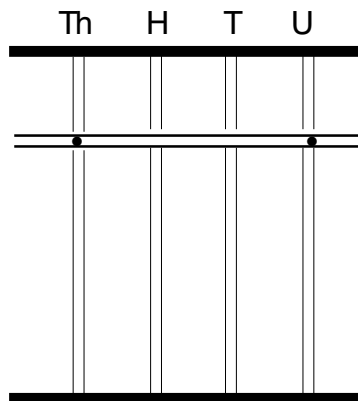
(3)



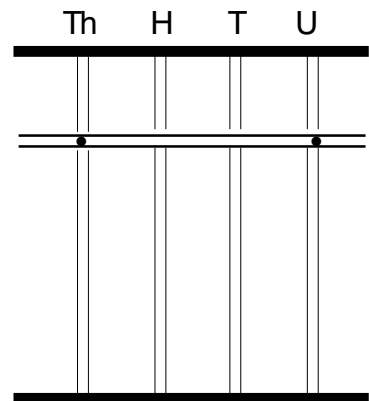
(18)



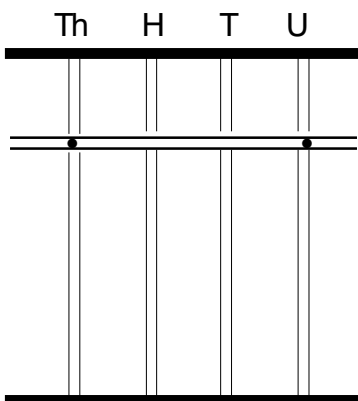
(58)



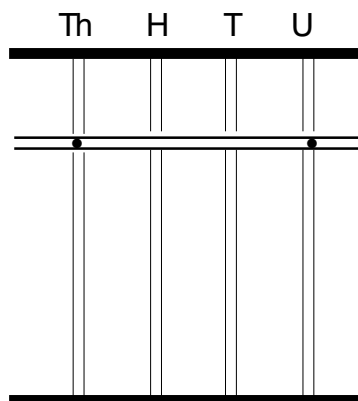
(1066)



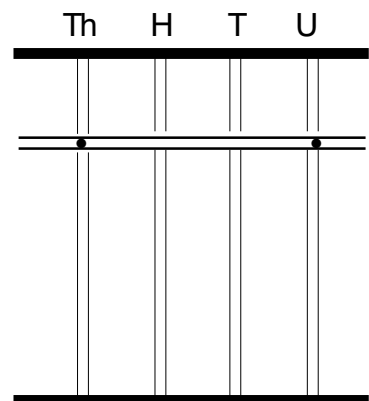
(1344)



(1953)



(1966)

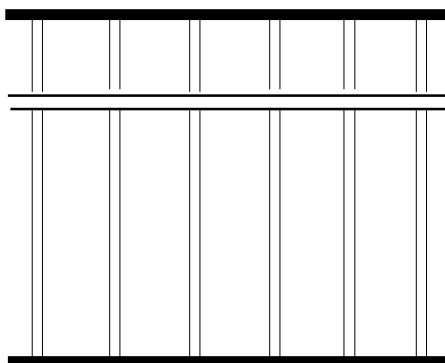


(2003)

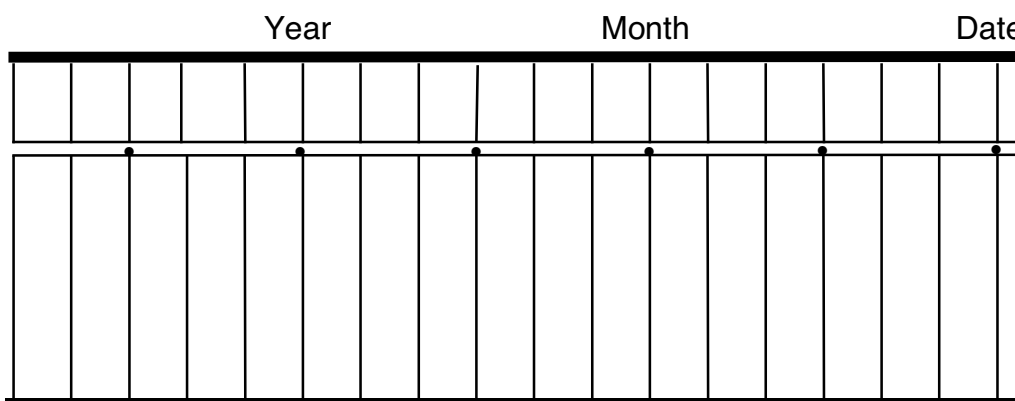
let's read the soroban

Draw your telephone number and your date of birth


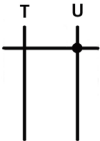
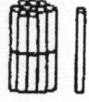
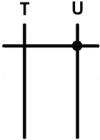

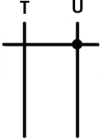
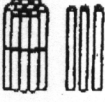
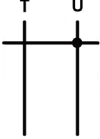
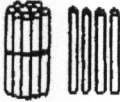
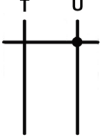
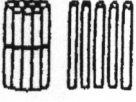
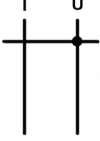
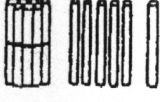
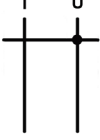
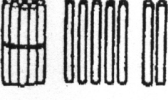
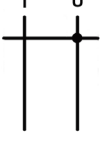

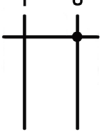

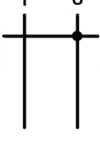

Tel: _____



Date of birth: _____



counting ten to twenty on the soroban

	Number	Number word	On Soroban
	10	ten	
	_____	_____	
	_____	_____	
	_____	_____	
	_____	_____	
	_____	_____	
	_____	_____	
	_____	_____	
	_____	_____	
	_____	_____	
	_____	_____	