



## 1, 3, 9 Challenge

The challenge is for the child to find number sentences to make all the numbers from 1 to 13 using just 1, 3, 9 together with one or more of + and/or -. The idea is for the child to practice experimenting with numbers and finding patterns, and hence help develop their 'number sense'. (And also to understand that maths is about finding things out for yourself – and to enjoy the experience.)

You can use one, two, or three of the numbers and you can use them in any order. Thus

$$1 = 1$$

$$4 = 1 + 3$$

$$7 = 9 - 3 + 1$$

The idea is to experiment. So start with “what is  $3 + 9$ ” rather than “how do I make..”

When you have found a lot of the answers, you can look for patterns to help find the rest.

1	
2	
3	
4	
5	
6	
7	
8	
9	
10	
11	
12	
13	

### Answers and discussion

1	= 1
2	= 3 - 1
3	= 3
4	= 3 + 1
5	= 9 - 3 - 1
6	= 9 - 3
7	= 9 - 3 + 1
8	= 9 - 1
9	= 9
10	= 9 + 1
11	= 9 + 3 - 1
12	= 9 + 3
13	= 9 + 3 + 1

Odd numbers have 1 or 3 numbers in the sum

Even number have 2 numbers in the sum

Why?

Because:

An odd number plus an odd number is even. (And an odd number minus an odd number is even.)

An even number plus an odd number is odd. (And an even number minus an odd number is odd.)

All of 1, 3, and 9 are odd.

So, if you have one number you have one odd number and the answer is odd.

If you have two numbers you have two odd numbers and the answer is even.

And if you have three numbers you have three odd numbers and the answer is odd again.

Writing out the number sentences up and down from 9 in two rows you get:

8 = 9 - 1	7 = 9 - 3 + 1	6 = 9 - 3	5 = 9 - 3 - 1
10 = 9 + 1	11 = 9 + 3 - 1	12 = 9 + 3	13 = 9 + 3 + 1

Can you describe the pattern?

Can you explain it?

Answer - comparing the top and bottom rows:

(a) The same numbers appear in each box (b) Every plus becomes a minus, and every minus a plus

Remember that on the number line adding one is counting up and subtracting one is counting down.

So 10 is  $9+1$ , 11, is  $9+2$ , 12 is  $9+3$ . Similarly 8 is  $9-1$ , 7 is  $9-2$ , and 6 is  $9-3$ .

This explains the pattern for 8 and 10, 6 and 12, and 5 and 13 – you count down or count up by the same amount so one has – and one has + but the numbers (1 and/or 3) are the same.

For 7 and 11 you have a + and a – ( $7 = 9 - 3 + 1$ ,  $11 = 9 + 3 - 1$ )

Try doing this on the number line:

Start at 9 and count down 3 and up 1 to get to 7. (Which is the same as counting down 2.)

Start at 9 and count up 3 and down 1 to get to 11. (which is the same as counting up 2.)

Harder – counting “1” as “plus 1” see that the pattern on the sums is “plus one, minus one, no one”

This works for 1, 2, 3, then starts again for 4, 5, 6, and then 7, 8, 9, and 10, 11, 12, and 13 starts “plus one”

The reason behind this pattern is difficult to explain to primary school children until they meet ‘remainders’ in year 5!

See if the child can find any other patterns.

### **A stretch challenge!**

(Only if the child is really enjoying the exercise.)

What is the pattern of the sequence 1, 3, 9?

What is the next number in the sequence?

If you use 1, 3, 9, and the next number in the sequence with + and -, can you make 14?

Answers

1 times 3 is 3

3 times 3 is 9

3 times 9 is 27

$27 - 9 - 3 - 1 = 14$

!

You can actually make all the numbers to 40 in the same way using 1, 3, 9, 27...

$40 = 27 + 9 + 3 + 1$