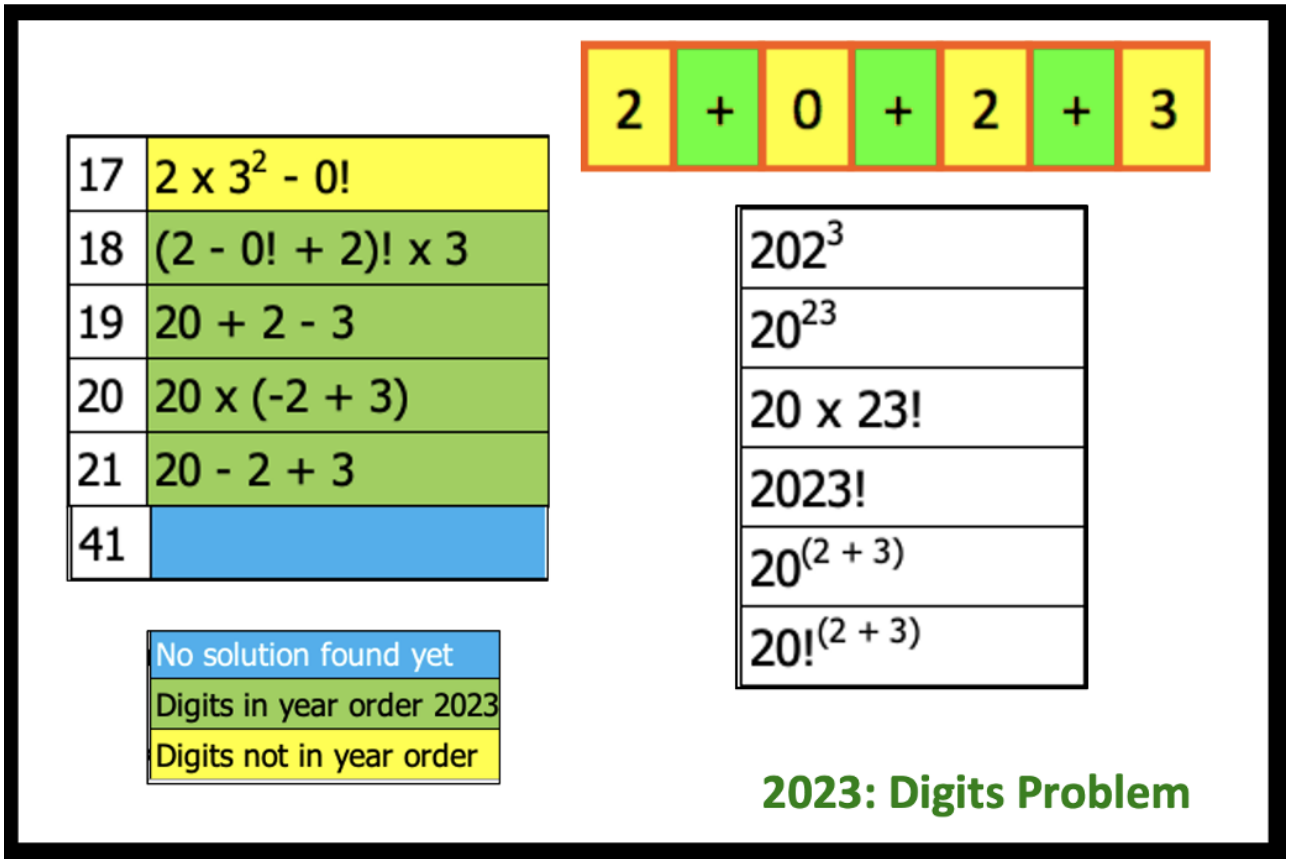
SPIRE MATHS

Stimulating, Practical, Interesting, Relevant, Enjoyable Maths For All

2023 Digits Problem



A Spire Maths Activity

https://spiremaths.co.uk/2023/

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2023 Digits Problem

Answers are on page 4. Colour pupil sheet on page 5, black pupil sheet on page 6

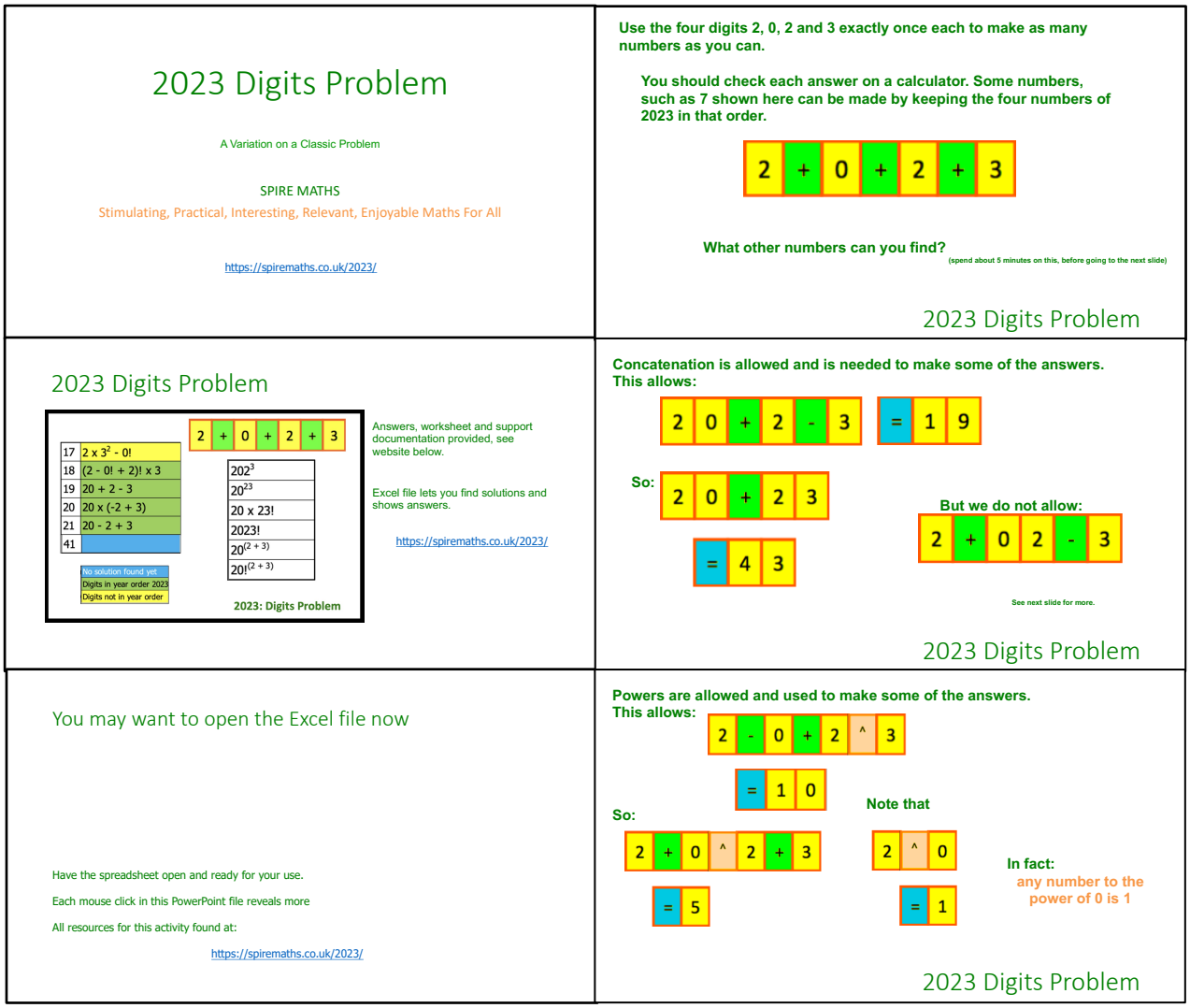
1. Make integers using the 4 digits of 2023 each once only, using add, subtract, multiply and divide, with brackets for clarity.
2. After about 5 minutes extend to allow Concatenation
3. After another 5 minutes allow Powers and Factorials noting that

   by convention any number to the power 0 is 1
   also by convention 0! = 1

4. Most numbers (72%) up to 50 can be made keeping the digits 2023 in that order.
5. The one that can't be made (2%) is: 41
6. Those not in order are (26%) are: 17, 22, 31, 33 to 35, 38 43 to 45, 47, 49, 50
7. Some very large numbers can be made using just these rules and some expressions created will 'break' the calculator or spreadsheet.

PowerPoint slides available (Similar also for ActivInspire)

Read down the first column, then down the second:



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The unitary operator FACTORIAL is needed to make some of the answers. $!$

Where

$4! = 1 \times 2 \times 3 \times 4$

$= 24$

$3! = 6$ $\quad 2! = 2$ $\quad 1! = 1$

And by international agreement (and important here):

$0! = 1$

What other numbers can you find?

2023 Digits Problem

No.	Expression	No.	Expression	No.	Expression
1	2 + 0 + 2 - 3	26	20 + (2 x 3)	54	2 x (0! + 2)!
2	2 x (0 - 2 + 3)	27	(2 - 0! + 2)!	66	(20 + 2) x 3
3	2 + 0 - 2 + 3	28	20 + 3!	72	(2 + 0 + 2)! x 3
4	2 + 0! - 2 + 3	29	2 + (0! + 2)!	100	20 x (2 + 3)
5	2 x 0 + 2 + 3	30	20 ÷ 2 x 3	117	(2+0! + 2)! - 3
6	2 x 0 + 2 x 3	31	$2^{(2+3)} - 0!$	120	20 x 2 x 3
7	2 + 0 + 2 + 3	32	$(2 + 0!)^{2+3}$	123	(2 + 0! +2)! + 3
8	2 + 0 + (2 x 3)	33	$2^{2+3} + 0!$	199	202 - 3
9	(2 + 0!) x 2 + 3	34	30 + 2 + 2	205	202 + 3
10	(2 + 0) x (2 + 3)	35	32 + 2 + 0!	360	(2 + 0! + 2)! x 3
11	(2 + 0!)! + 2 + 3	36	(2 + 0!)! x 2 x 3	397	$202^2 - 3$
12	(2 + 0 + 2) x 3	37	20 x 2 - 3	403	$20^2 + 3$
13	20 ÷ 2 + 3	38	32 + (2 + 0!)!	460	20 x 23
14	20 - (2 x 3)	39	$(2 + 0!)^2 + 3$	606	202 x 3
15	20 - 2 - 3	40	(2 + 0! + 2)! ÷ 3	1200	$20^2 \times 3$
16	$2^{(0! + 2 + 3)}$	41		5832	$(20 - 2)^3$
17	$2 \times 3^2 - 0!$	42	(2 + 0!)! + 2)! + 3	10648	$(20 + 2)^3$
18	(2 - 0! + 2)! x 3	43	20 x 2 + 3		
19	20 + 2 - 3	44	22 x (3 - 0!)		
20	20 x (-2 + 3)	45	2 x 23 - 0!		
21	20 - 2 + 3	46	(2 + 0!) x 23		
22	(2 + 2)! - 3 + 0!	47	2 x 23 + 0!		
23	2 x 0 + 23	48	$(2 + 0!) \times 2^3$		
24	(2 + 0! - 2 + 3)!	49	$((2 \times 3) + 0!)^2$		
25	20 + 2 + 3	50	$(3! - 0!)^2 \times 2$		

Materials and spreadsheet found at: https://spiremaths.co.uk/2023/

Convention: all positive integers to power 0 are 1	No solution found yet
4! = 1 x 2 x 3 x 4 = 24 etc.	Digits in year order 2023
By convention 0! = 1	20 + 2 + 2 etc is OK — Digits not in year order

2023 Some solutions

Here are the numbers we have found so far up to 50 and beyond:

No.	Expression	No.	Expression	No.	Expression	No.	Expression
1		26		54			
2		27		66			
3		28		72			
4		29		100			
5		30		117			
6		31		120			
7		32		123			
8		33		199			
9		34		205			
10		35		360			
11		36		397			
12		37		403			
13		38		460			
14		39		606			
15		40		1200			
16		41		5832			
17		42		10648			
18		43					
19		44					
20		45					
21		46					
22		47					
23		48					
24		49					
25		50					

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Convention: all positive integers to power 0 are 1	No solution found yet
4! = 1 x 2 x 3 x 4 = 24 etc.	Digits in year order 2023
By convention 0! = 1	20 + 2 + 3 etc is OK — Digits not in year order

No solution yet for
41

Solution not in 2023 order
17, 22, 31,33 to 35, 38, 43 to 45, 47, 49, 50

All others have been found in the order of 2023

2023 Digits Problem

Here are some ideas for larger numbers that can be made. Which do you think will be the largest?

Which will 'break' your calculator?

202^3	8,242,408
20^{23}	8.38861E+29
20 x 23!	5.1704E+23
2023!	#NUM!
$20^{(2 + 3)}$	3,200,000
$20!^{(2 + 3)}$	8.5236E+91

2023 Extras

Here are the numbers we have found so far up to 50 and beyond:

No.	Expression	No.	Expression	No.	Expression
1		26		60	
2		27		72	
3		28		80	
4		29		101	
5		30		118	
6		31		122	
7		32		200	
8		33		204	
9		34		204	
10		35		240	
11		36		324	
12		37		398	
13		38		402	
14		39		404	
15		40		440	
16		41		480	
17		42		484	
18		43			
19		44			
20		45			
21		46			
22		47			
23		48			
24		49			
25		50			

No solution yet for
41

Solution not in 2023 order
17, 22, 31,33 to 35, 38, 43 to 45, 47, 49, 50

All others have been found in the order of 2023

2023 Digits Problem

Here are some ideas for larger numbers that can be made. Which do you think will be the largest?

Here they are in order

$20^{(2 + 3)}$	3,200,000
202^3	8,242,408
20 x 23!	5.1704E+23
20^{23}	8.38861E+29
$20!^{(2 + 3)}$	8.5236E+91
2023!	#NUM!

2023 Extras

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No.	Expression
1	2 + 0 + 2 - 3
2	2 x (0 - 2 + 3)
3	2 + 0 - 2 + 3
4	2 + 0! - 2 + 3
5	2 x 0 + 2 + 3
6	2 x 0 + 2 x 3
7	2 + 0 + 2 + 3
8	2 + 0 + (2 x 3)
9	(2 + 0!) x 2 + 3
10	(2 + 0) x (2 + 3)
11	(2 + 0!)! + 2 + 3
12	(2 + 0 + 2) x 3
13	20 ÷ 2 + 3
14	20 - (2 x 3)
15	20 - 2 - 3
16	$2^{(-0! + 2 + 3)}$
17	2 x 3^2 - 0!
18	(2 - 0! + 2)! x 3
19	20 + 2 - 3
20	20 x (-2 + 3)
21	20 - 2 + 3
22	(2 + 2)! - 3 + 0!
23	2 x 0 + 23
24	(2 + 0! - 2 + 3)!
25	20 + 2 + 3

No.	Expression
26	20 + (2 x 3)
27	$(2 - 0! + 2)^3$
28	$20 + 2^3$
29	$2 + (0! + 2)^3$
30	20 ÷ 2 x 3
31	$2^{(2 + 3)}$ - 0!
32	$(2 + 0)^{(2 + 3)}$
33	$2^{(2 + 3)}$ + 0!
34	30 + 2 + 2
35	32 + 2 + 0!
36	(2 + 0!)! x 2 x 3
37	20 x 2 - 3
38	32 + (2 + 0!)!
39	$(2 + 0!)!^2$ + 3
40	(2 + 0! + 2)! ÷ 3
41	
42	(2 + 0!)! + 2)! ÷ 3
43	20 x 2 + 3
44	22 x (3 - 0!)
45	2 x 23 - 0!
46	(2 + 0) x 23
47	2 x 23 + 0!
48	(2 + 0!)! x 2^3
49	$((2 \times 3) + 0!)^2$
50	$(3! - 0!)^2$ x 2

No.	Expression
54	2 x $(0! + 2)^3$
66	(20 + 2) x 3
72	(2 + 0 + 2)! x 3
100	20 x (2 + 3)
117	(2+0! + 2)! - 3
120	20 x 2 x 3
123	(2 + 0! +2)! + 3
199	202 - 3
205	202 + 3
360	(2 + 0! + 2)! x 3
397	20^2 - 3
403	20^2 + 3
460	20 x 23
606	202 x 3
1200	20^2 x 3
5832	$(20 - 2)^3$
10648	$(20 + 2)^3$

Materials and spreadsheet found https://spiremaths.co.uk/2023/

	Convention: all positive integers to power 0 are 1		No solution found yet
	4! = 1 x 2 x 3 x 4 = 24 etc.		Digits in year order 2023
	By convention 0! = 1		20 + 2 + 2 etc is OK

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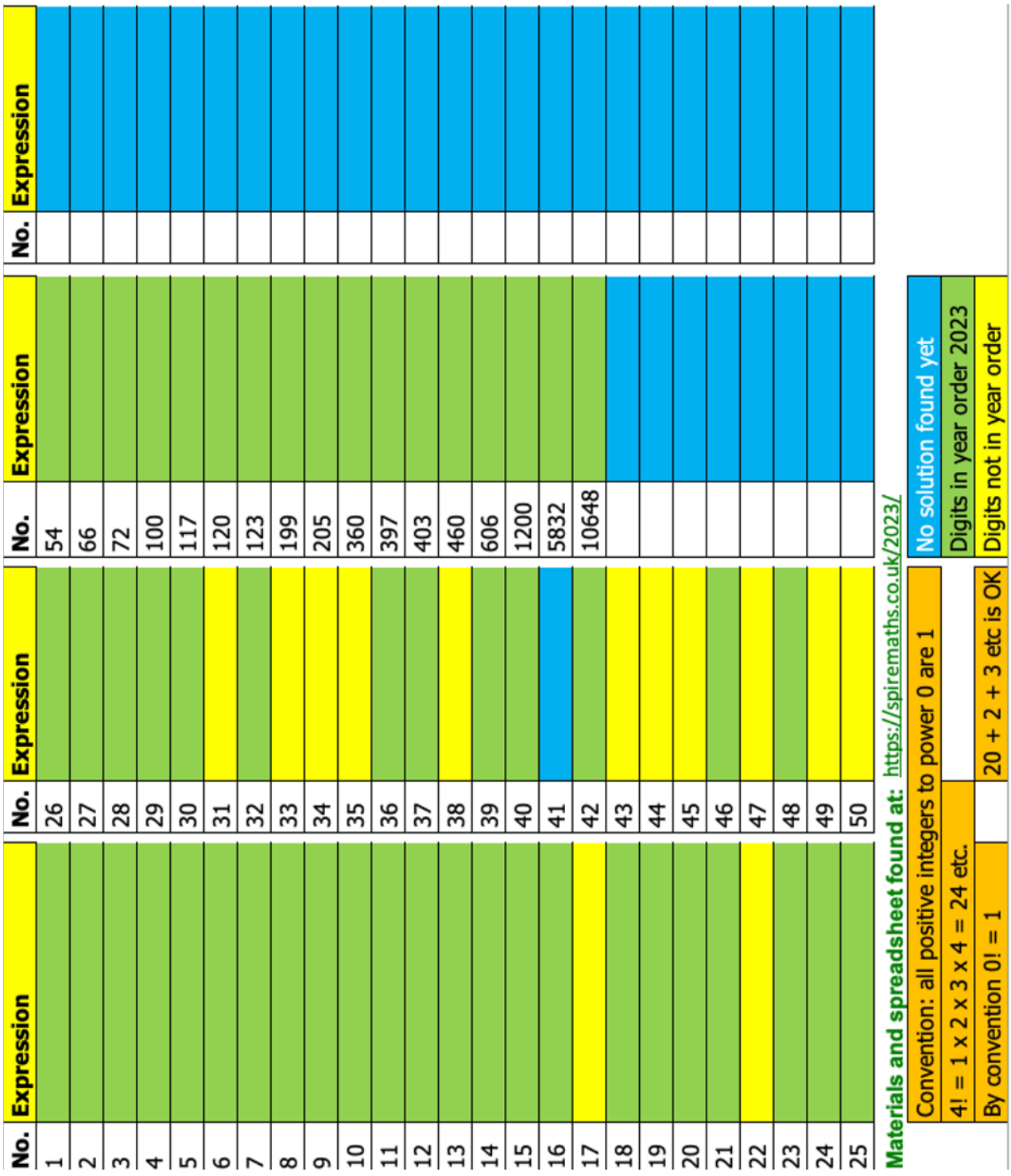
2023 Digits Problem

Make these numbers using the digits 2, 0, 2 and 2 exactly once each



No.	Expression
1	
2	
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4	
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14	
15	
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20	
21	
22	
23	
24	
25	

No.	Expression
26	
27	
28	
29	
30	
31	
32	
33	
34	
35	
36	
37	
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39	
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41	
42	
43	
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48	
49	
50	

No.	Expression
54	
66	
72	
100	
117	
120	
123	
199	
205	
360	
397	
403	
460	
606	
1200	
5832	
10648	

No.	Expression

Materials and spreadsheet found at: https://spiremaths.co.uk/2023/

Convention: all positive integers to power 0 are 1

4! = 1 x 2 x 3 x 4 = 24 etc.

By convention 0! = 1

20 + 2 + 3 etc is OK

No solution found yet

Digits in year order 2023

Digits not in year order

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2023 Digits Problem

No.	Expression
1	
2	
3	
4	
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No.	Expression
26	
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49	
50	

No.	Expression
60	
72	
80	
101	
118	
122	
200	
204	
204	
240	
324	
398	
402	
404	
440	
480	
484	