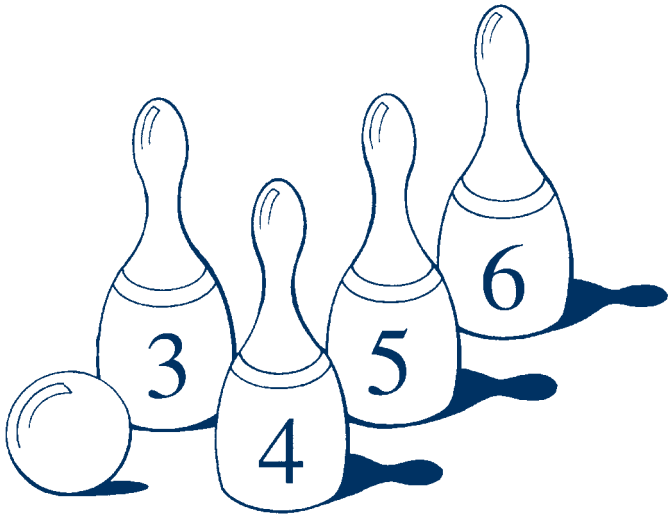
The National
Numeracy Strategy

Reasoning about numbers, with challenges and simplifications



The activities in this booklet should help children to:

- solve mathematical problems or puzzles, recognise and explain patterns and relationships, generalise and predict;
- explain methods and reasoning orally and in writing;
- suggest extensions by asking 'What if …?'

Many of the activities have supplementary objectives, such as:

- add several numbers;
- use known number facts and place value to add, subtract, multiply or divide mentally;
- recognise multiples.

Handshakes

- Everyone in this room shakes hands with everyone else.

  How many handshakes are there?

Simplifications

- How many handshakes would there be for 3 people? And 5 people?

Challenges

- How many handshakes would there be for 100 people?
- Generalise using words or symbols.

The answer is...

The answer is 24.

What was the question?

- How many different questions can you write with an answer of 24?
- What is the hardest question that you can write with an answer of 24?

Simplifications

- How many different questions can you write with an answer of 10?
- How many different addition sums can you write with an answer of 24?

Challenges

- How many different questions can you write with an answer of 0.35?
- How many different questions can you write with an answer of 24 using all the operations $+$, $-$, $\times$ and $\div$ at least once in each question?
- Randomly choose three 0–9 number cards. Try to write a question with an answer of 24 that uses the numbers on these three cards.

Decigame

A game for two players.

The winner is the first player to get three of their marks in a row without any of the other player's marks in-between.

Rules

- Take turns to choose two numbers from the table below:

1	2	3	4	5	8	10	20

- Divide one number by the other to make a number between 0 and 1.
- Mark your answer on the number line below:

- Numbers can be used more than once.

Simplifications

- Use a number line which is divided into tenths:

- Use a 0–100 number line and the numbers 1 to 10 in the table. Players choose two numbers and multiply them together.

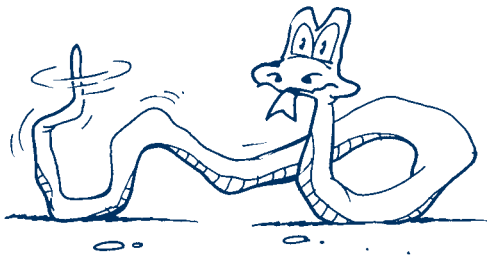
Challenges

- Use a 0–5 number line. Add the numbers 6, 9, 12, 15, 16 and 18 to the table.
- Use a 0–10 number line and the table below:

1.5	0.8	2.4	0.6	4.8	0.3	6.0	3.6

Choose two numbers and multiply or divide them.

Snakes



- Choose a number less than 10.

$$9$$

- If the number is even, halve it and add 1. If the number is odd, double it.

$$9 \rightarrow 18$$

- Carry on in this way.

$$9 \rightarrow 18 \rightarrow 10 \rightarrow 6 \rightarrow 4 \rightarrow \ldots$$

- What happens?

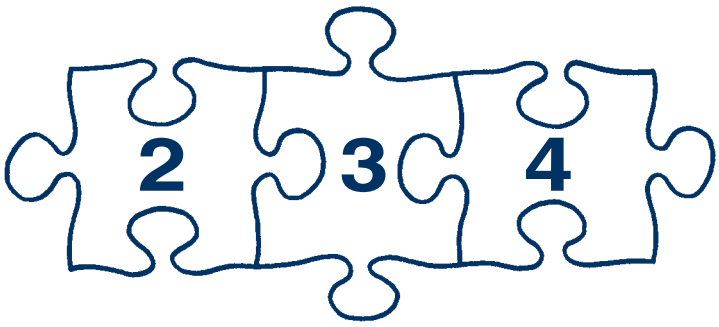
Simplifications

- Give starting numbers which produce short snakes.

Challenges

- Start with a two-digit number.
- Investigate which numbers produce the longest snakes.
- Find snakes that contain all the numbers from 1 to 20.

Consecutive sums



$$5 = 2 + 3$$

$$12 = 3 + 4 + 5$$

- Which other numbers can you make by adding consecutive numbers?
- Which numbers can be made in more than one way?

Simplifications

- Try to find consecutive numbers that add together to make each of the numbers from 5 to 20.
- What totals can you make using two or more numbers from the set 1, 2, 3, 4, 5?

Challenges

- Which numbers can be made by adding two consecutive numbers? Which numbers can be made by adding three consecutive numbers?
- Which numbers cannot be made by adding consecutive numbers? Why?

Magic squares

This square is magic.

4	3	8
9	5	1
2	7	6

The sum of every row, column and diagonal is the same, 15.
15 is the magic total for this square.

- Complete these magic squares using the numbers 1–9:

	7	
1		
		4

	1	
		7
		2

- Can you make up two more magic squares using the numbers 1–9?
- Is a magic square still magic if you add 2 to each number? Double each number? Why?
- What happens when you add or subtract two magic squares?

Simplifications

- Use 0–9 number cards. Use as many as you can to make trios of numbers that add up to 13. Make trios of numbers that add up to different totals.
- Use nine of the 0–9 number cards. Arrange the cards in a 3 by 3 grid so that each row adds up to 13.
- Choose from the numbers 0–9. Arrange the numbers in a 3 by 3 grid so that each row and column adds up to 13. You can use a number more than once.

Challenges

- Arrange 2, 4, 5, 7, 8, 10 into this square to make it magic.

3		
	6	
		9

- Make a 3 by 3 magic square using the numbers 3–11.
- Make a 3 by 3 magic square using any nine consecutive numbers.
- Make different 3 by 3 magic squares which have a magic total of 27.

Getting even

A game for two players.

The winner is the first player to score 10 points.

Rules

- The first player writes down any two-digit number without showing it to the other player.

$$34$$

- At the same time, the second player also writes down any two-digit number without showing it to the other player.

$$55$$

- Players show each other their numbers and together find the total.

$$34 + 55 = 89$$

- If the answer is even the first player scores 1 point.
  If the answer is odd the second player scores 1 point.

Simplifications

- Use single-digit numbers.

Challenges

- Is this a fair game?
- Play the game but multiply the two numbers together. Is this game fair?
- What happens when three or four numbers are added or multiplied?

Different products

- Make up some multiplications that use the numbers above.

  For example:

$$3 \times 4$$

$$2 \times 3 \times 4$$

$$3 \times 21$$

- How many different products can you make?

Simplifications

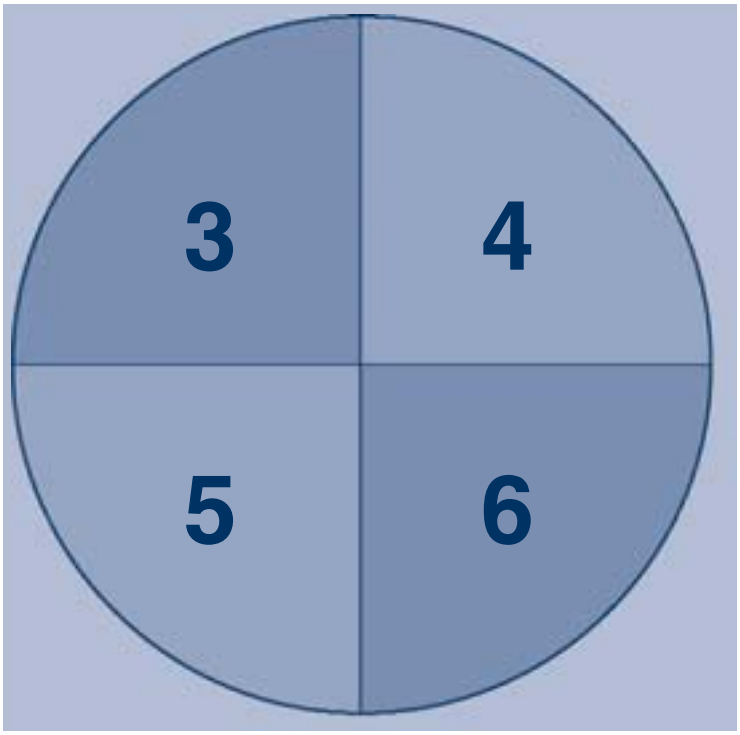
- How many different sums can you make by adding two or more of the numbers?
- How many different differences can you make by subtracting two of the numbers?
- Use only three of the numbers.

Challenges

- What is the biggest product you can make?
- Generalise for any four numbers.
- Investigate different products using five numbers.

Score board

You need 3 counters.



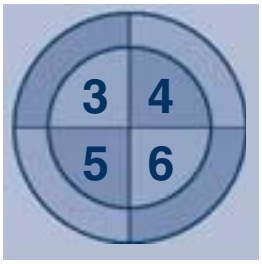
- Put the 3 counters on the board so that each one scores. There can be more than one counter in each part of the board.
- Add up the numbers to get a score.
- What different scores can you make?

Simplifications

- Use smaller numbers on the board.
- Divide the board up into only three sections and use two counters.
- What is the biggest score you can make?

Challenges

- Use two-digit numbers or decimal fractions on the board.
- Use a board with more sections.
- Use a board with a 'doubles' ring around the outside.



- Multiply the numbers to get your score.

Sum to twelve

The sum of 5 and 7 is 12.

$$5 + 7 = 12$$

The sum of 2, 4 and 6 is also 12.

$$2 + 4 + 6 = 12$$

- What other numbers sum to 12?

Simplifications

- Use a rod of 12 multilink cubes which can be partitioned in different ways.
- What numbers sum to 6?
- In how many different ways can you write 5 as the sum of 1s and 2s?

Challenges

- Investigate all the number sentences it is possible to make for other sums.
- $12 = 5 + 7$
  and
  $5 \times 7 = 35$.

  $12 = 2 + 4 + 6$
  and
  $2 \times 4 \times 6 = 48$.

  What is the largest product you can make from numbers that sum to 12?

Changing money

I have one 50p, one 20p, one 10p, one 5p, one 2p and one 1p in my pocket.

- How much money have I got altogether?
- If I pulled any two coins out of my pocket, how much might they be worth?
- What if I pulled three coins out of my pocket, or four coins out of my pocket, or...?

Simplifications

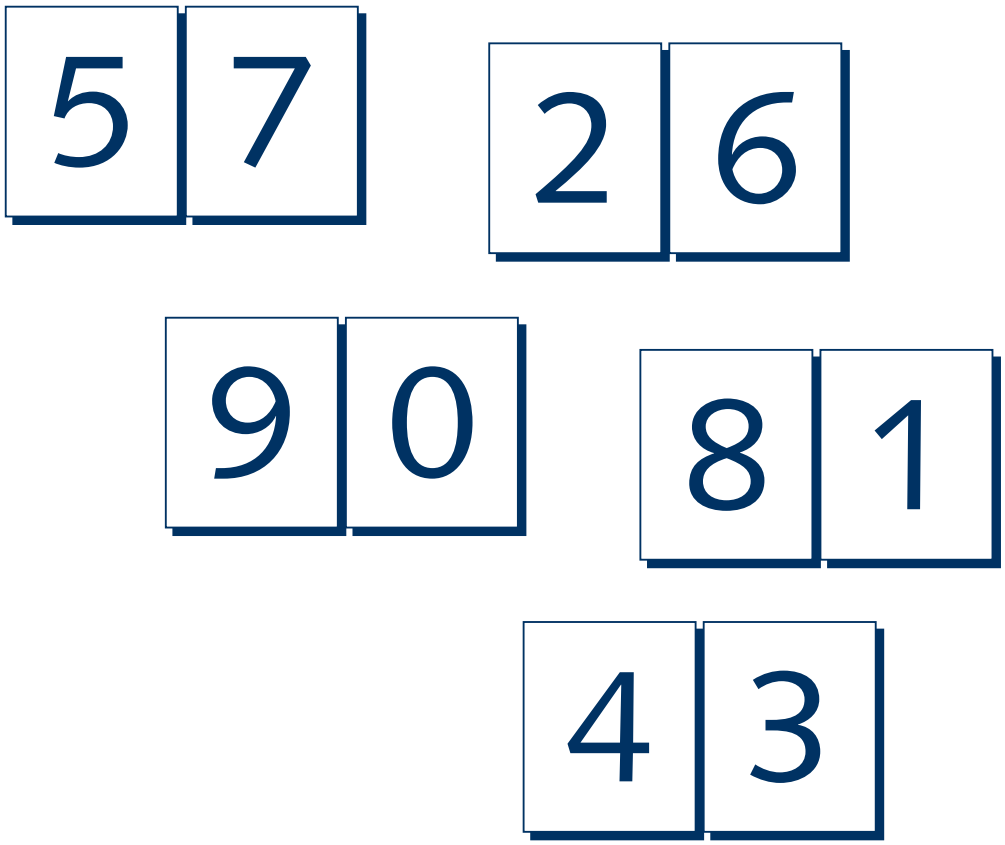
- Use only 4 coins.
- What different coins could add together to make 10p?
- I have 3 coins in my pocket. How much money could I have altogether?

Challenges

- You have a bag containing lots of 2p coins and lots of 5p coins. What amounts of money **can't** you make?
- I was asked to change a £1 coin. I had more than £1 in my pocket, but I could not make exactly £1. How much money could I have had in my pocket?

Ordering numbers

- Use a set of 0–9 number cards to make some two-digit numbers.



- Arrange these numbers in order.

Simplifications

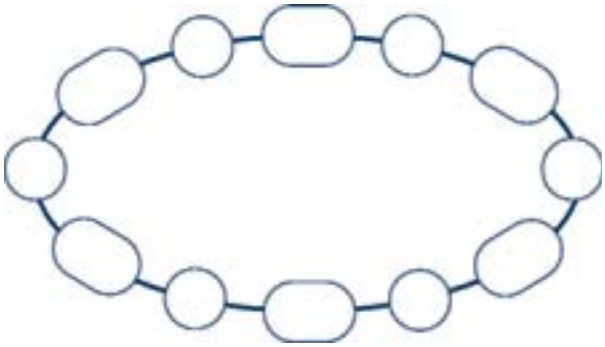
- Time how long it takes to order a shuffled set of 0–20 cards.
- Use a number line to help with the ordering.

Challenges

- Order sets of three-digit numbers.
- Use each card only once. Make the five largest two-digit numbers possible.
- Make five even numbers.
- Make five multiples of 3.

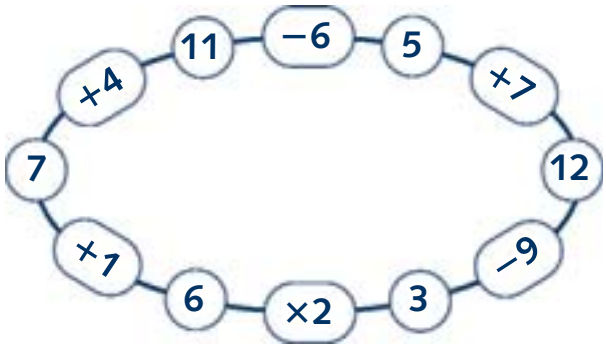
Bracelets

- Write some numbers in the circles on the bracelet below:



- Write in appropriate operations to complete the bracelet.

  For example:



- Make up some different bracelets.

Simplifications

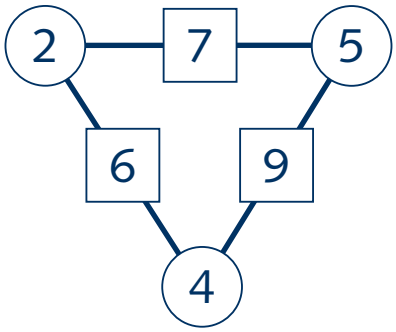
- Use single-digit addition and subtraction only.
- Give the children a starting number and all the functions.
- Make shorter bracelets.

Challenges

- Use multiplication and division only.
- Use two-digit numbers or decimal fractions in the circles.
- Make longer bracelets.

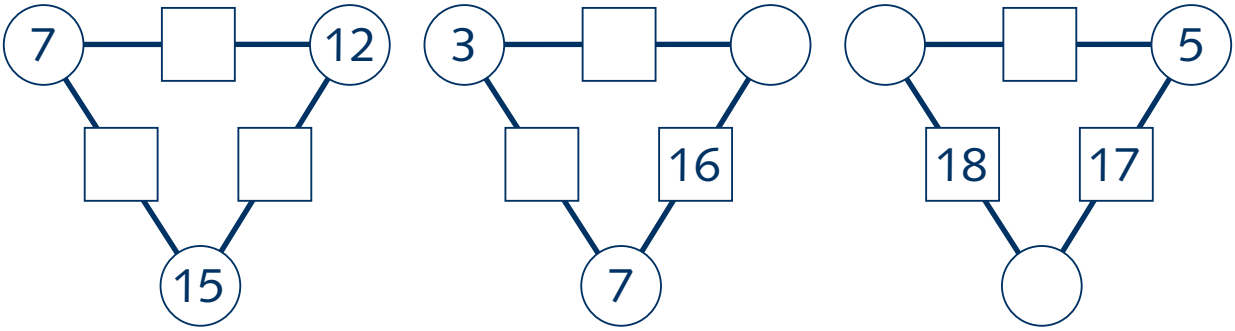
Arithmogons

Look at the diagram below:



The numbers in the squares are made by adding the numbers in the circles.

- Complete the diagrams below:



Simplifications

- Use single-digit numbers only.
- Only make the numbers in the squares given the numbers in all the circles.
- The numbers in the squares are made by finding the difference between the numbers in the circles.

Challenges

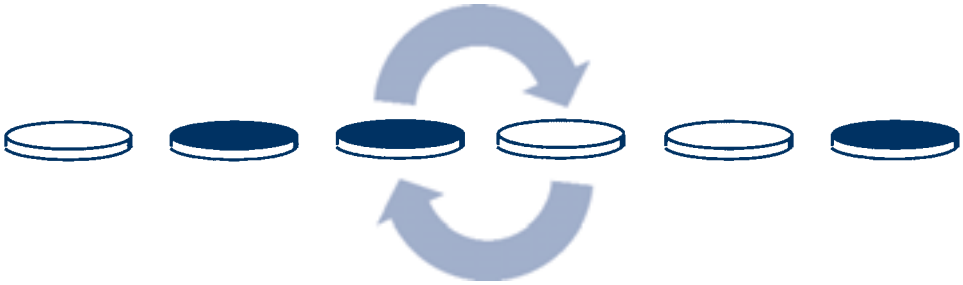
- Use two-digit numbers or decimal fractions.
- Give all three numbers in the squares and find the three numbers in the circles.
- The numbers in the squares are made by multiplying the numbers in the circles.

Swapping places

You need some counters.

Arrange some yellow and some blue counters alternately in a line.

Counters next to each other can swap places.



- How many swaps does it take to have all the yellow counters together and all the blue counters together?

Simplifications

- How many swaps would there be for 2 counters of each colour?
- How many swaps would there be for 3 counters of each colour?
- How many swaps would there be for 4 counters of each colour?

Challenges

- How many swaps would there be for 100 counters of each colour?
- Generalise, using words or symbols, when there is the same number of each coloured counter.
- Investigate different numbers of blue and yellow counters: for example, 2 blue and 3 yellow counters.
- Investigate swapping 3 different coloured counters.

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