Answers

Solving mathematical problems

Multiples (p.8)

Challenge

	0	2	4	6	8	10	12	14	16	18	20

	0	5	10	15	20	25	30	35	40	45	50
+	0	7	14	21	28	35	42	49	56	63	70
–	0	3	6	9	12	15	18	21	24	27	30

When adding together pairs of numbers that are above and below each other the answers are all multiples of 7.

What if?

When finding the difference between pairs of numbers that are above the line (i.e. multiples of 2) and below the line (i.e. multiples of 5) the answers are all multiples of 3. (See the multiples of 2 and 5 number line above.)

Multiples of 2 and 3

	0	2	4	6	8	10	12	14	16	18	20

	0	3	6	9	12	15	18	21	24	27	30
+	0	5	10	15	20	25	30	35	40	45	50
–	0	1	2	3	4	5	6	7	8	9	10

When adding together pairs of numbers that are above and below each other the answers are all multiples of 5.

When finding the difference between pairs of numbers that are above and below each other the answers are all multiples of 1.

Multiples of 3 and 5

	0	3	6	9	12	15	18	21	24	27	30
	0	5	10	15	20	25	30	35	40	45	50
+	0	8	16	24	32	40	48	56	64	72	80
–	0	2	4	6	8	10	12	14	16	18	20

When adding together pairs of numbers that are above and below each other the answers are all multiples of 8.

When finding the difference between pairs of numbers that are above and below each other the answers are all multiples of 2.

2-digit numbers (p.9)

Challenge

	Smallest 2-digit number	Largest 2-digit number
even number	10	98
odd number	13	97
multiple of 2	10	98
multiple of 3	12	96
multiple of 5	15	95
multiple of 10	10	90

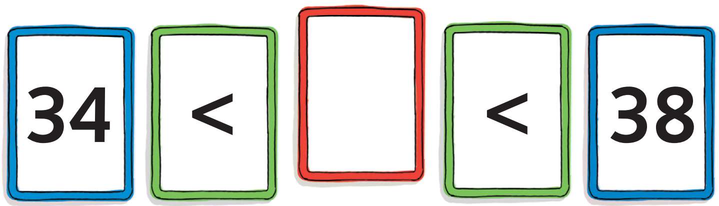
What if?

	All the numbers between 40 and 50	Number closest to 64
even number	42, 46, 48	64
odd number	41, 43, 45, 47, 49	63 and 65
multiple of 3	42, 45, 48	63
multiple of 5	45	65
multiple of 10	no numbers	60

Ordering numbers (p.10)

Challenge

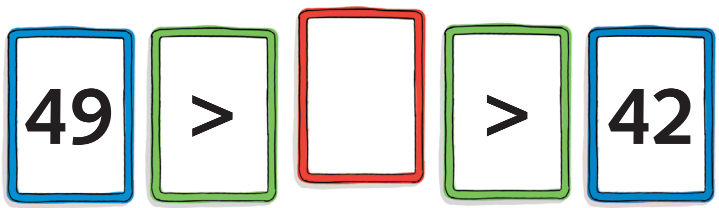
Pupils' descriptions of the rules will vary, however they should refer to the following. You will need to use your professional judgement when assessing pupils' reasoning.



Numbers on the red card: 35, 36 or 37

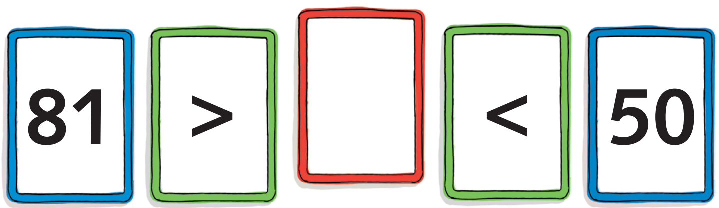
Rule: Any number greater than 34 and less than 38 / Any number between 34 and 38.

What if?



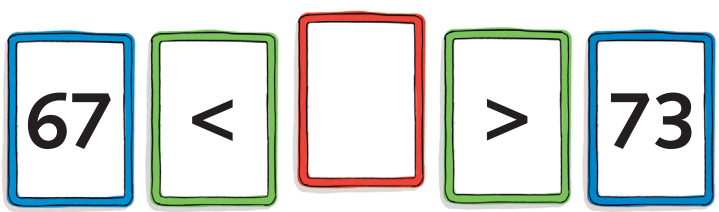
Numbers on the red card: 48, 47, 46, 45, 44 or 43

Rule: Any number less than 49 and greater than 42 / Any number between 42 and 49.



Numbers on the red card: 0–49 (inclusive)

Rule: Any number less than 50.



Numbers on the red card: Any number greater than 73.

Rule: Any number greater than 73.

Number grid (p.11)

Challenge

Both totals are the same, e.g.

1	2
7	8

1 + 8 = 9

2 + 7 = 9

What if?

For any square of four numbers, the differences between the pairs of the two numbers in the opposite corners are always the same. In the case of the 1 to 36, 6 by 6 grid, the differences are 7 and 5.

1	2
7	8

8 – 1 = 7

7 – 2 = 5

5	6
11	12

12 – 5 = 7

11 – 6 = 5

NOTE: Pupils with a greater depth of understanding may notice that the number between 7 and 5, i.e. 6, is the same as the number of columns in the grid.

1 to 20, 5 by 4 grid:

- Both totals are the same.
- The differences between the pairs of the two numbers in the opposite corners are always the same, i.e. 6 and 4.

NOTE: Pupils with a greater depth of understanding may notice that the number between 6 and 4, i.e. 5, is the same as the number of columns in the grid.

1 to 16, 4 by 4 grid:

- Both totals are the same.
- The differences between the pairs of the two numbers in the opposite corners are always the same, i.e. 5 and 3.

NOTE: Pupils with a greater depth of understanding may notice that the number between 5 and 3, i.e. 4, is the same as the number of columns in the grid.

1 to 100, 10 by 10 grid:

- Both totals are the same.
- The differences between the pairs of the two numbers in the opposite corners are always the same, i.e. 11 and 9.

NOTE: Pupils with a greater depth of understanding may notice that the number between 11 and 9, i.e. 10, is the same as the number of columns in the grid.

Stepping stones (p.12)

Challenge

Totals will vary. The number of stones that pupils land on, and add together, will vary depending on the pupils' depth of understanding.

What if?

Moving from 'Start' to 'End':

- The greatest total you can make without stepping on a stone more than once is 68, i.e. stepping on each stone once: 4 + 7 + 5 + 6 + 3 + 9 + 5 + 2 + 9 + 1 + 4 + 7 + 6.
- The greatest total you can make by stepping on five numbered steps is 31, i.e. 7 + 6 + 5 + 9 + 4.
- The smallest total you can make is 20, i.e. 7 + 3 + 5 + 1 + 4.

Alice got a total of 40 by stepping on 4 + 7 + 6 + 5 + 1 + 4 + 7 + 6.

Darts (p.13)

Challenge

There are 55 different ways of scoring 20 points using three darts.

NOTE: Calculations in brackets, e.g. (2×2), refer to a ‘hit’ inside the green section, i.e. a double of the score.

$9 + 9 + 2$	$(2 \times 2) + 8 + 8$	$(2 \times 2) + (2 \times 4) + 8$	$(2 \times 8) + (2 \times 1) + (2 \times 1)$
$9 + 8 + 3$	$(2 \times 2) + 9 + 7$	$(2 \times 2) + (2 \times 5) + 6$	$(2 \times 7) + (2 \times 2) + (2 \times 1)$
$9 + 7 + 4$	$(2 \times 3) + 7 + 7$	$(2 \times 2) + (2 \times 6) + 4$	$(2 \times 6) + (2 \times 1) + (2 \times 3)$
$9 + 6 + 5$	$(2 \times 3) + 8 + 6$	$(2 \times 2) + (2 \times 7) + 2$	$(2 \times 6) + (2 \times 2) + (2 \times 2)$
$8 + 8 + 4$	$(2 \times 3) + 9 + 5$	$(2 \times 3) + (2 \times 3) + 8$	$(2 \times 6) + (2 \times 3) + (2 \times 1)$
$8 + 7 + 5$	$(2 \times 4) + 6 + 6$	$(2 \times 3) + (2 \times 4) + 6$	$(2 \times 5) + (2 \times 4) + (2 \times 1)$
$7 + 7 + 6$	$(2 \times 4) + 7 + 5$	$(2 \times 3) + (2 \times 5) + 4$	$(2 \times 5) + (2 \times 3) + (2 \times 2)$
$6 + 6 + 8$	$(2 \times 4) + 8 + 4$	$(2 \times 3) + (2 \times 6) + 2$	$(2 \times 4) + (2 \times 3) + (2 \times 3)$
	$(2 \times 4) + 9 + 3$	$(2 \times 4) + (2 \times 4) + 4$	$(2 \times 4) + (2 \times 4) + (2 \times 2)$
	$(2 \times 5) + 5 + 5$	$(2 \times 4) + (2 \times 5) + 2$	
	$(2 \times 5) + 6 + 4$	$(2 \times 5) + (2 \times 1) + 8$	
	$(2 \times 5) + 7 + 3$	$(2 \times 6) + (2 \times 1) + 6$	
	$(2 \times 5) + 8 + 2$	$(2 \times 7) + (2 \times 1) + 4$	
	$(2 \times 5) + 9 + 1$	$(2 \times 8) + (2 \times 1) + 2$	
	$(2 \times 6) + 1 + 7$		
	$(2 \times 6) + 2 + 6$		
	$(2 \times 6) + 3 + 5$		
	$(2 \times 6) + 4 + 4$		
	$(2 \times 7) + 1 + 5$		
	$(2 \times 7) + 2 + 4$		
	$(2 \times 7) + 3 + 3$		
	$(2 \times 8) + 1 + 3$		
	$(2 \times 8) + 2 + 2$		
	$(2 \times 9) + 1 + 1$		

What if?

The smallest points total you can score using three darts is 3, i.e. 1 + 1 + 1.

The largest points total you can score using three darts is 48, i.e. (2 × 8) + (2 × 8) + (2 × 8).

Accept any scores that are calculated using three darts and the rule.

Card calculations (p.14)

Challenge

2-digit number add 1-digit number:

Calculations will vary depending on the digit cards chosen by the pupils. However, it is possible to make six different addition number sentences choosing three cards, e.g. 3, 8 and 9 digit cards:

3 + 98

3 + 89

8 + 93

8 + 39

9 + 83

9 + 38

What if?

2-digit number subtract 1-digit number:

Calculations will vary depending on the digit cards chosen by the pupils. However, it is possible to make six different subtraction number sentences choosing three cards, e.g. 3, 8 and 9 digit cards:

98 – 3

89 – 3

93 – 8

39 – 8

83 – 9

38 – 9

2-digit number add / subtract 2-digit number:

Calculations will vary depending on the digit cards chosen by the pupils. However, it is possible to make 24 different addition and 12 different subtraction number sentences choosing four cards, e.g. 1, 5, 6 and 7 digit cards:

15 + 67	61 + 57	56 – 17
15 + 76	61 + 75	57 – 16
16 + 57	65 + 17	61 – 57
16 + 75	65 + 71	65 – 17
17 + 56	67 + 15	67 – 15
17 + 65	67 + 51	67 – 51
51 + 67	71 + 56	71 – 56
51 + 76	71 + 65	71 – 65
56 + 17	75 + 16	75 – 16
56 + 71	75 + 61	75 – 61
57 + 16	76 + 15	76 – 15
57 + 61	76 + 51	76 – 51

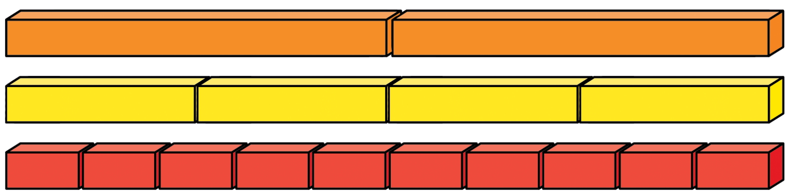
Cuisenaire rods (p.15)

Challenge

10 × 2 = 20 / 20 ÷ 2 = 10

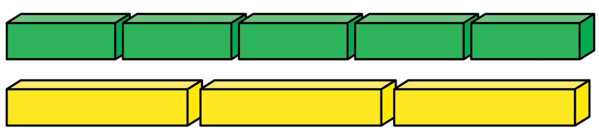
5 × 4 = 20 / 20 ÷ 4 = 5

2 × 10 = 20 / 20 ÷ 10 = 2



3 × 5 = 15 / 15 ÷ 5 = 3

5 × 3 = 15 / 15 ÷ 3 = 5



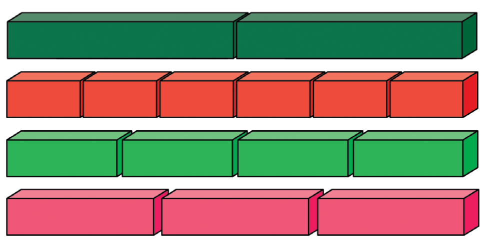
What if?

6 × 2 = 12 / 12 ÷ 2 = 6

2 × 6 = 12 / 12 ÷ 6 = 2

3 × 4 = 12 / 12 ÷ 4 = 3

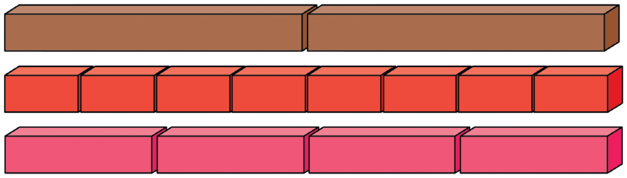
4 × 3 = 12 / 12 ÷ 3 = 4



$8 \times 2 = 16$ / $16 \div 2 = 8$

$2 \times 8 = 16$ / $16 \div 8 = 2$

$4 \times 4 = 16$ / $16 \div 4 = 4$



Make a multiplication (p.16)

Challenge

$2 \times 3 = 6$ / $3 \times 2 = 6$

$2 \times 4 = 8$ / $4 \times 2 = 8$

$2 \times 5 = 10$ / $5 \times 2 = 10$

$2 \times 6 = 12$ / $6 \times 2 = 12$

$2 \times 10 = 20$ / $10 \times 2 = 20$

$3 \times 4 = 12$ / $4 \times 3 = 12$

$3 \times 5 = 15$ / $5 \times 3 = 15$

$3 \times 6 = 18$ / $6 \times 3 = 18$

$3 \times 10 = 30$ / $10 \times 3 = 30$

$4 \times 5 = 20$ / $5 \times 4 = 20$

$4 \times 6 = 24$ / $6 \times 4 = 24$

$4 \times 10 = 40$ / $10 \times 4 = 40$

$5 \times 6 = 30$ / $6 \times 5 = 30$

$5 \times 10 = 50$ / $10 \times 5 = 50$

$6 \times 10 = 60$ / $10 \times 6 = 60$

What if?

$10 \div 2 = 5$ / $10 \div 5 = 2$

$4 \div 2 = 2$

$6 \div 2 = 3$ / $6 \div 3 = 2$

Multiplying and dividing by 2 (p.17)

Challenge

Pupils will record their results in various ways. The following show calculations for combinations of one- and two-digit numbers only. Pupils with a greater depth of understanding may include calculations involving three-digit numbers, e.g. 69 × 2 = 138 / 138 ÷ 2 = 69.

1 × 2 = 2 / 2 ÷ 2 = 1

2 × 2 = 4 / 4 ÷ 2 = 2

3 × 2 = 6 / 6 ÷ 2 = 3

4 × 2 = 8 / 8 ÷ 2 = 4

5 × 2 = 10 / 10 ÷ 2 = 5

6 × 2 = 12 / 12 ÷ 2= 6

7 × 2 = 14 / 14 ÷ 2 = 7

8 × 2 = 16 / 16 ÷ 2 = 8

9 × 2 = 18 / 18 ÷ 2 = 9

13 × 2 = 26 / 26 ÷ 2 = 13

14 × 2 = 28 / 28 ÷ 2 = 14

15 × 2 = 30 / 30 ÷ 2 = 15

16 × 2 = 32 / 32 ÷ 2 = 16

17 × 2 = 34 / 34 ÷ 2 = 17

18 × 2 = 36 / 36 ÷ 2 = 18

19 × 2 = 38 / 38 ÷ 2 = 19

23 × 2 = 46 / 46 ÷ 2 = 23

27 × 2 = 54 / 54 ÷ 2 = 27

28 × 2 = 56 / 56 ÷ 2 = 28

29 × 2 = 58 / 58 ÷ 2 = 29

31 × 2 = 62 / 62 ÷ 2 = 31

32 × 2 = 64 / 64 ÷ 2 = 32

34 × 2 = 68 / 68 ÷ 2 = 34

35 × 2 = 70 / 70 ÷ 2 = 35

36 × 2 = 72 / 72 ÷ 2 = 36

38 × 2 = 76 / 76 ÷ 2 = 38

39 × 2 = 78 / 78 ÷ 2 = 39

41 × 2 = 82 / 82 ÷ 2 = 41

43 × 2 = 86 / 86 ÷ 2 = 43

45 × 2 = 90 / 90 ÷ 2 = 45

46 × 2 = 92 / 92 ÷ 2 = 46

48 × 2 = 96 / 96 ÷ 2 = 48

What if?

If you can use the same digit card twice when making pairs of numbers, then as well as the above calculations, the following calculations are also possible.

10 × 2 = 20 / 20 ÷ 2 = 10	22 × 2 = 44 / 44 ÷ 2 = 22	33 × 2 = 66 / 66 ÷ 2 = 33
11 × 2 = 22 / 22 ÷ 2 = 11	24 × 2 = 48 / 48 ÷ 2 = 24	37 x 2 = 74 / 74 ÷ 2 = 37
12 × 2 = 24 / 24 ÷ 2 = 12	25 × 2 = 50 / 50 ÷ 2 = 25	40 × 2 = 80 / 80 ÷ 2 = 40
20 × 2 = 40 / 40 ÷ 2 = 20	26 × 2 = 52 / 52 ÷ 2 = 26	42 × 2 = 84 / 84 ÷ 2 = 42
21 × 2 = 42 / 42 ÷ 2 = 21	30 × 2 = 60 / 60 ÷ 2 = 30	44 × 2 = 88 / 88 ÷ 2 = 44
		47 × 2 = 94 / 94 ÷ 2 = 47
		49 × 2 = 98 / 98 ÷ 2 = 49

If you use the cards to make pairs of numbers so that one number is five times the other number, then the following combinations of one- and two-digit numbers are possible. Pupils with a greater depth of understanding may include calculations involving three-digit numbers, e.g. 27 × 5 = 135 / 135 ÷ 5 = 27.

1 × 5 = 5 / 5 ÷ 5 = 1	7 × 5 = 35 / 35 ÷ 5 = 7	13 × 5 = 65 / 65 ÷ 5 = 13
2 × 5 = 10 / 10 ÷ 5 = 2	8 × 5 = 40 / 40 ÷ 5 = 8	14 × 5 = 70 / 70 ÷ 5 = 14
3 × 5 = 15 / 15 ÷ 5 = 3	9 × 5 = 45 / 45 ÷ 5 = 9	15 × 5 = 75 / 75 ÷ 5 = 15
4 × 5 = 20 / 20 ÷ 5 = 4	10 × 5 = 50 / 50 ÷ 5 = 10	16 × 5 = 80 / 80 ÷ 5= 16
5 × 5 = 25 / 25 ÷ 5 = 5	11 × 5 = 55 / 55 ÷ 5 = 11	17 × 5 = 85 / 85 ÷ 5 = 17
6 × 5 = 30 / 30 ÷ 5= 6	12 × 5 = 60 / 60 ÷ 5 = 12	18 × 5 = 90 / 90 ÷ 5 = 18
		19 × 5 = 95 / 95 ÷ 5 = 19

Halving chains (p.18)

Challenge

Pupils' chains will vary, depending on their depth of understanding.

The longest possible chain starting with a two-digit number is a six-link chain starting with 64, i.e.

64 → 32 → 16 → 8 → 4 → 2 → 1

What if?

Pupils' three-digit number halving chains will vary, depending on their depth of understanding.

Pupils should realise that they can start with any number, not just an even number, to make a doubling chain.

Four cubes (p.19)

Challenge

For a shape of four cubes made from red and blue interlocking cubes:

3 red and 1 blue: $\frac{3}{4}$ red and $\frac{1}{4}$ blue

2 red and 2 blue: $\frac{2}{4}$ red and $\frac{2}{4}$ blue; or $\frac{1}{2}$ red and $\frac{1}{2}$ blue

1 red and 3 blue: $\frac{1}{4}$ red and $\frac{3}{4}$ blue

What if?

For a shape of four cubes made from red, blue and green interlocking cubes:

2 red, 1 blue and 1 green: $\frac{2}{4}$ red, $\frac{1}{4}$ blue and $\frac{1}{4}$ green; or $\frac{1}{2}$ red, $\frac{1}{4}$ blue and $\frac{1}{4}$ green

1 red, 2 blue and 1 green: $\frac{1}{4}$ red, $\frac{2}{4}$ blue and $\frac{1}{4}$ green; or $\frac{1}{4}$ red, $\frac{1}{2}$ blue and $\frac{1}{4}$ green

1 red, 1 blue and 2 green: $\frac{1}{4}$ red, $\frac{1}{4}$ blue and $\frac{2}{4}$ green; or $\frac{1}{4}$ red, $\frac{1}{4}$ blue and $\frac{1}{2}$ green

For a shape of six cubes made from red and blue interlocking cubes:

5 red and 1 blue: $\frac{5}{6}$ red and $\frac{1}{6}$ blue

4 red and 2 blue: $\frac{4}{6}$ red and $\frac{2}{6}$ blue; or $\frac{2}{3}$ red and $\frac{1}{3}$

3 red and 3 blue: $\frac{3}{6}$ red and $\frac{3}{6}$ blue; or $\frac{1}{2}$ red and $\frac{1}{2}$ blue

2 red and 4 blue: $\frac{2}{6}$ red and $\frac{4}{6}$ blue; or $\frac{1}{3}$ red and $\frac{2}{3}$

1 red and 5 blue: $\frac{1}{6}$ red and $\frac{5}{6}$ blue

Fraction statements (p.20)

Challenge

Pupils' statements will vary, depending on their depth of understanding. However, these should be based on the following criteria:

- male / female
- adult / child
- wearing glasses / not wearing glasses
- dark or brown hair / fair or blonde hair
- striped top / solid top / spotted top
- smiling / frowning
- wearing a hat / not wearing a hat

- holding an animal / not holding an animal
- human / animal

What if?

Pupils' statements will vary, depending on their depth of understanding. However, these should be based on the following criteria:

- male / female
- adult / child
- dark ginger / fair ginger
- coloured frosting / white frosting only
- wearing a bow tie / not wearing a bow tie
- wearing a ribbon in their hair / not wearing a ribbon in their hair
- smiling / frowning

Fraction wall (p.21)

Challenge

$\frac{1}{2} = \frac{2}{4} = \frac{3}{6} = \frac{4}{8} = \frac{5}{10} = \frac{6}{12}$

$\frac{1}{4} = \frac{2}{8} = \frac{3}{12}$

Pupils' statements will vary, depending on their depth of understanding. Statements may include:

- The top number is half the bottom number. / The bottom number is twice (double) the top number.
- Multiply the top number (numerator) and the bottom number (denominator) by the same whole number.

What if?

The following fractions are all equivalent to 1 whole:

$2 \times \frac{1}{2}$ $(\frac{2}{2})$

$3 \times \frac{1}{3}$ $(\frac{3}{3})$

$4 \times \frac{1}{4}$ $(\frac{4}{4})$

$5 \times \frac{1}{5}$ $(\frac{5}{5})$

$6 \times \frac{1}{6}$ $(\frac{6}{6})$

$8 \times \frac{1}{8}$ $(\frac{8}{8})$

$10 \times \frac{1}{10}$ ($\frac{10}{10}$)

$12 \times \frac{1}{12}$ ($\frac{12}{12}$)

Pupils' statements will vary, depending on their depth of understanding. Statements may include:

- The top number (numerator) is the same as the bottom number (denominator).

Giraffe order (p.22)

Challenge

Tula, Bala, Molly and Gilmore.

Pupils' statements will vary, depending on their depth of understanding. Statements may include:

Compare two giraffes:

Tula < Bala / Bala > Tula

Tula < Molly / Molly > Tula

Tula < Gilmore / Gilmore > Tula

Bala < Molly / Molly > Bala

Bala < Gilmore / Gilmore > Bala

Molly < Gilmore / Gilmore > Molly

Compare three giraffes:

Tula < Bala < Molly / Molly > Bala > Tula

Bala < Molly < Gilmore / Gilmore > Molly > Bala

Molly < Gilmore > Bala / Bala < Gilmore > Molly

Tula < Molly < Gilmore / Gilmore > Molly > Tula

Gilmore > Tula < Bala / Bala > Tula < Gilmore

Compare four giraffes:

Tula < Bala < Molly < Gilmore / Gilmore > Molly > Bala > Tula

Molly < Gilmore > Tula < Bala / Bala > Tula < Gilmore > Molly

Gilmore > Molly > Tula < Bala / Bala > Tula < Molly < Gilmore

Bala < Gilmore > Molly > Tula / Tula < Molly < Gilmore > Bala

Tula < Molly < Gilmore > Bala / Bala < Gilmore > Molly > Tula

What if?

Tula is 2 m tall.

Bala is 3 m tall.

Molly is 5 m tall.

Gilmore is 6 m tall.

100 g to 1 kg (p.23)

Challenge

Matthew is right.

100 g = 100 g

200 g = 200 g

300 g = 200 g + 100 g

400 g = 200 g + 200 g

500 g = 500 g

600 g = 500 g + 100 g

700 g = 500 g + 200 g

800 g = 500 g + 200 g + 100 g

900 g = 500 g + 200 g + 200 g

1 kg = 500 g + 500 g

What if?

Each weight from 200 g to 1 kg can be made in other ways, e.g.

200 g = 100 g + 100 g

300 g = 100 g + 100 g + 100 g

400 g = 200 g + 100 g + 100 g

500 g = 200 g + 200 g + 100 g

600 g = 200 g + 200 g + 200 g

700 g = 500 g + 100 g + 100 g

800 g = 500 g + 100 g + 100 g + 100 g

900 g = 200 g + 200 g + 200 g + 200 g + 100 g

1 kg = 500 g + 200 g + 200 g + 100 g

Making 1 litre (p.24)

Challenge

A and E

B and D

C and F

What if?

Other amounts using two cylinders:

A + B = 1150 ml

A + C = A + F = 1250 ml

A + D = 1350 ml

B + C = B + F = 900 ml

B + E = 650 ml

C + D = D + F = 1100 ml

D + E = 850 ml

E + F = 750 ml

Ordering time (p.25)

Challenge

Events and ordering will vary.

What if?

This part of the challenge is designed to encourage pupils to think about the 24-hour cycle of a day and consider how, for example, at quarter past eight they could be eating breakfast (morning / a.m.) or getting ready for bed (evening / p.m.).

Buying sweets (p.26)

Challenge

Accept any combination of six different sweets that total £1, e.g.

2 gob stoppers (2 × 20p = 40p)

2 liquorice (2 × 10p = 20p)

2 bananas (2 × 5p = 10p)

5 chews (5 × 3p = 15p)

5 milk bottles (5 × 2p = 10p)

5 raspberries (5 × 1p = 5p)

What if?

Accept any combination of four different sweets that total £1, e.g.

2 gob stoppers (2 × 20p = 40p)

3 liquorice (3 × 10p = 30p)

3 bananas (3 × 5p = 15p)

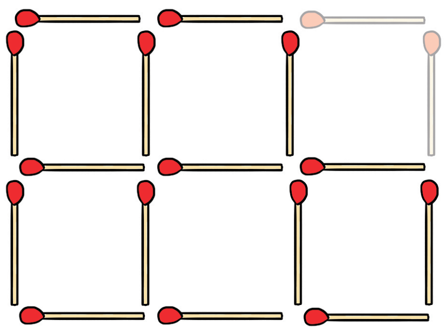
5 chews (5 × 3p = 15p)

Matchsticks (p.27)

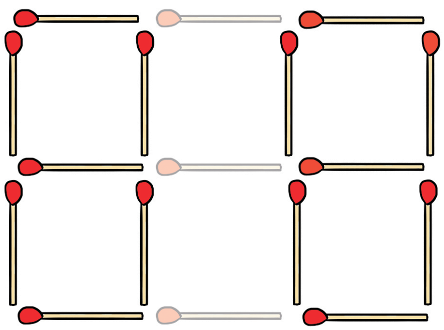
Challenge

Several answers are possible for each.

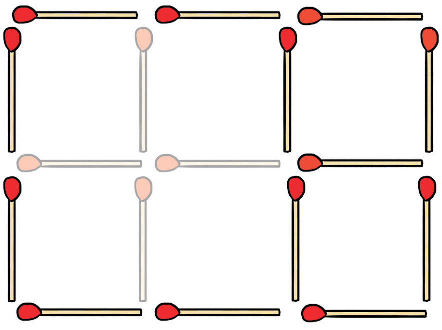
Remove 2 matchsticks to leave 5 squares.



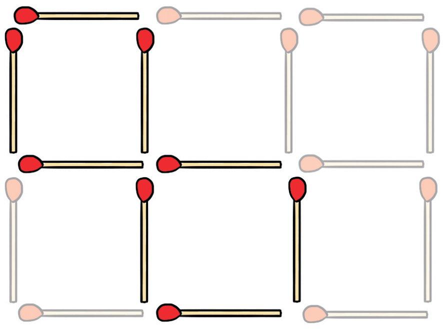
Remove 3 matchsticks to leave 4 squares.



Remove 4 matchsticks to leave 3 squares.



Remove 9 matchsticks to leave 2 squares.

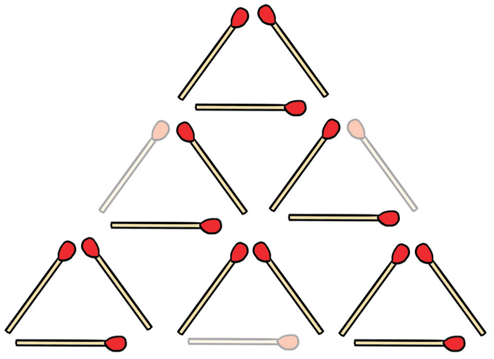


What if?

Several answers are possible for each.

Remove 3 matchsticks to leave 6 triangles.

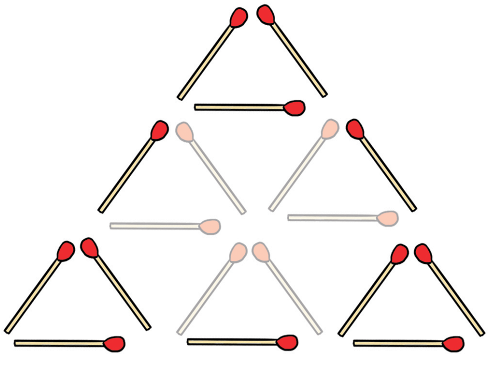
All the triangles are the same size.



Remove 6 matchsticks to leave 4 triangles.

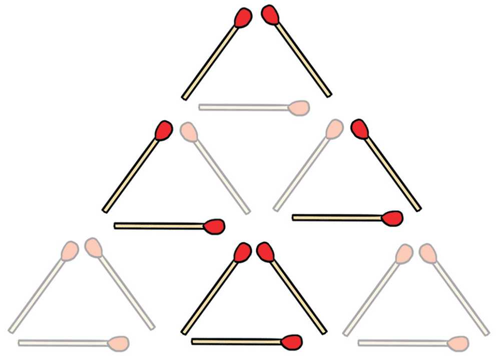
All the triangles are not the same size.

(3 small triangles and 1 large triangle.)



Remove 9 matchsticks to leave 4 triangles.

All the triangles are not the same size.



Sorting shapes (p.28)

Challenge

Pupils' criteria for sorting will vary. Some sample criteria are provided below for guidance. Use your professional judgement when assessing pupils' responses to open-ended questions and their reasoning.

Criteria may include:

- 2-D shape / 3-D shape
- the number of sides / edges / faces
- the number of vertices (corners)
- straight sides / edges / faces or curved sides / edges / faces
- symmetrical properties.

What if?

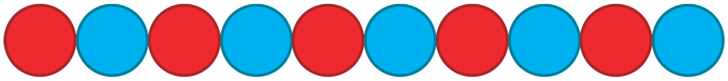
Criteria may include:

- the number of faces
- the number of edges
- the number of vertices (corners)
- flat faces or curved faces
- straight edges or curved edges.

Making patterns (p.29)

Challenge

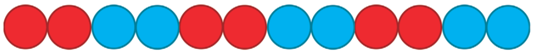
Pupils' patterns will vary. Some sample patterns are provided below for guidance. Use your professional judgement when assessing pupils' responses to open-ended questions and their reasoning.



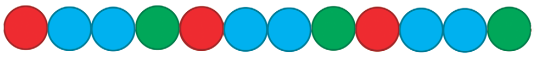
AB, e.g. 

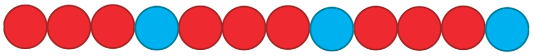
AAB, e.g. 

ABB, e.g. 

AABB, e.g. 

ABC, e.g. 

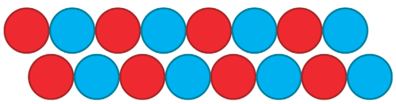
ABBC, e.g. 

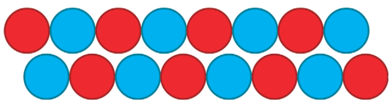
AAABAAAB, e.g. 

ABCCD, e.g. 

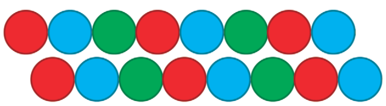
What if?

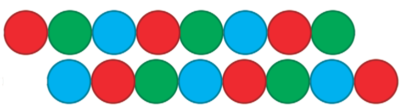
16 counters of two different colours, e.g.





16 counters of three different colours, e.g.





Turning (p.30)

Challenge

Statements will vary. Pupils should use a variety of words such as: whole, half, quarter, three-quarter, right, left, right angle, clockwise and anticlockwise.

From A to B: $\frac{1}{4}$ turn (or 1 right angle) to the right or $\frac{3}{4}$ turn (or 3 right angles) to the left

From A to C: $\frac{1}{2}$ turn (or 2 right angles) to the right or $\frac{1}{2}$ turn (or 2 right angles) to the left

From A to D: $\frac{3}{4}$ turn (or 3 right angles) to the right or $\frac{1}{4}$ turn (or 1 right angle) to the left

From B to C: $\frac{1}{4}$ turn (or 1 right angle) to the right or $\frac{3}{4}$ turn (or 3 right angles) to the left

From B to D: $\frac{1}{2}$ turn (or 2 right angles) to the right or $\frac{1}{2}$ turn (or 2 right angles) to the left

From B to A: $\frac{3}{4}$ turn (or 3 right angles) to the right or $\frac{1}{4}$ turn (or 1 right angle) to the left

From C to D: $\frac{1}{4}$ turn (or 1 right angle) to the right or $\frac{3}{4}$ turn (or 3 right angles) to the left

From C to A: $\frac{1}{2}$ turn (or 2 right angles) to the right or $\frac{1}{2}$ turn (or 2 right angles) to the left

From C to B: $\frac{3}{4}$ turn (or 3 right angles) to the right or $\frac{1}{4}$ turn (or 1 right angle) to the left

From D to A: $\frac{1}{4}$ turn (or 1 right angle) to the right or $\frac{3}{4}$ turn (or 3 right angles) to the left

From D to B: $\frac{1}{2}$ turn (or 2 right angles) to the right or $\frac{1}{2}$ turn (or 2 right angles) to the left

From D to C: $\frac{3}{4}$ turn (or 3 right angles) to the right or $\frac{1}{4}$ turn (or 1 right angle) to the left

What if?

Statements will vary, e.g. *You can move from A to B by making a quarter turn (or 1 right angle) to the right or by making a three-quarter turn (or 3 right angles) to the left.*

Card sort (p.31)

Challenge

Criteria used for sorting the cards could include:

- black card or red card
- heart, diamond, club or spade
- number card or 'court' card
- even number or odd number.

Pupils may choose to record the data in a list or table.

What if?

Similar criteria to that above can be used for sorting the cards into Venn diagrams, e.g.

- black card / even number
- diamond / ‘court’ card
- the number 5 or more / spade

Similar criteria to that above can be used for sorting the cards into Carroll diagrams, e.g.

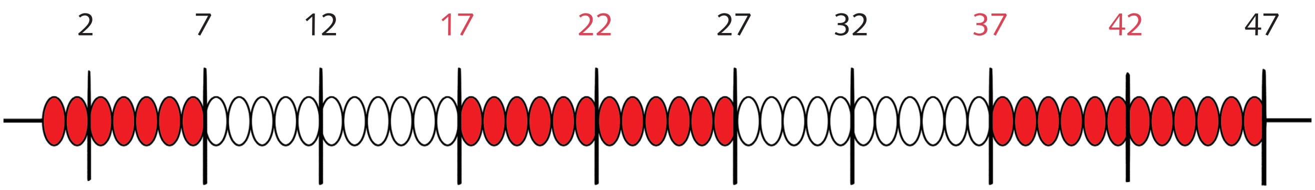
- black card or not black card / even number or not an even number
- heart or not a heart / ‘court’ card or not a ‘court’ card
- the number 5 or less or not the number 5 or less / red or not red

Reasoning mathematically

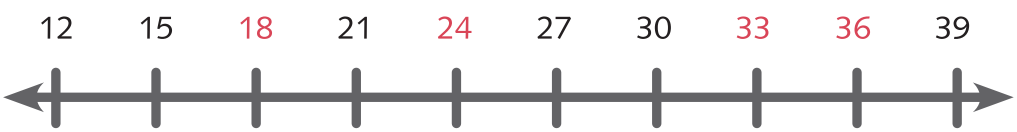
Step counting (p.32)

Challenge

The missing numbers are shown in red.



Counting on in steps of 5.



Counting on in steps of 3.

2	12	22	32	42
4	14	24	34	44
6	16	26	36	46
8	18	28	38	48
10	20	30	40	50

Counting on in steps of 2.

What if?

Pupils' explanations will vary, depending on their depth of understanding. However, they should refer to the following. Use your professional judgement when assessing pupils' reasoning.

Alice is right. When you count in steps of 10 from a number, the ones digit stays the same, e.g. 3, 13, 23, 33, 43, 53, … 113, 123, 133, 143, …

Which is larger? (p.33)

Challenge

Dylan is correct – 6 tens and 8 ones (68) is smaller than 5 tens and 19 ones (69).

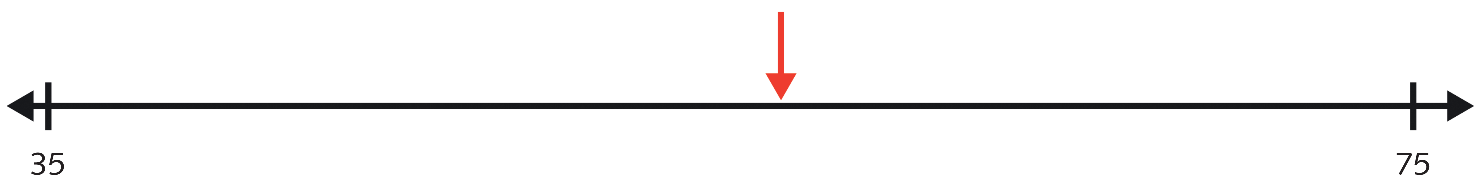
What if?

Dylan is correct – 4 tens and 28 ones (68) is the same as 6 tens and 8 ones (68).

Odd one out (p.34)

Challenge

The number line that does not point to the number 63 is the 35 to 75 number line. The arrow should be approximately in the following position:



What if?

Pupils' number lines will vary.

Hard or easy? (p.35)

Challenge

Pupils' grouping and explanations will vary.

What if?

Pupils' number sentences will vary.

Same answer, different numbers (p.36)

Challenge

42 + 29 = 71

43 + 28 = 71

44 + 27 = 71

45 + 26 = 71

46 + 25 = 71

47 + 24 = 71

48 + 23 = 71

49 + 22 = 71

Pupils should notice that the two missing ones digits total 11.

What if?

87 – 30 = 57

88 – 31 = 57

89 – 32 = 57

The two missing ones digits have a difference of 7.

04 + 95 = 99 *

14 + 85 = 99

24 + 75 = 99

34 + 65 = 99

44 + 55 = 99

54 + 45 = 99

64 + 35 = 99

74 + 25 = 99

84 + 15 = 99

94 + 05 = 99 *

The two missing tens digits total 9.

33 – 07 = 26 *

43 – 17 = 26

53 – 27 = 26

63 – 37 = 26

73 – 47 = 26

83 – 57 = 26

93 – 67 = 26

The two missing tens digits have a difference of 3.

* Most pupils will probably not include zero as the placeholder and express 04, 05 and 07 as 4, 5 and 7 respectively.

Always, sometimes, never (p.37)

Challenge

Matthew's statement is always true: *When you add two odd numbers together, the answer is an even number,* e.g. 1 + 3 = 4 / 1 + 5 = 6 / 3 + 5 = 8.

Dylan's statement is sometimes true: *When you add any three numbers, the answer is an odd number*, i.e.

True:

E + E + O = O, e.g. 2 + 4 + 1 = 7 / 2 + 4 + 3 = 9 / 2 + 6 + 1 = 9

O + O + O = O, e.g. 1 + 3 + 5 = 9 / 1 + 3 + 7 = 11 / 3 + 5 + 7 = 15

O + E + E = O, e.g. 1 + 2 + 4 = 7 / 1 + 4 + 6 = 11 / 3 + 2 + 4 = 9

False:

E + E + E = E, e.g. 2 + 4 + 6 = 12 / 2 + 4 + 8 = 14 / 2 + 6 + 8 = 16

E + O + O = E, e.g. 2 + 1 + 3 = 6 / 2 + 3 + 5 = 10 / 4 + 1 + 3 = 8

O + O + E = E, e.g. 1 + 3 + 2 = 6 / 1 + 3 + 4 = 8 / 3 + 5 + 2 = 10

Alice's statement is never true: *When you add an odd number and an even number, the answer is even* (the answer is always an odd number), e.g. 1 + 2 = 3 / 3 + 4 = 7 / 7 + 6 = 13. The same applies when adding an even number and an odd number, e.g. 2 + 5 = 7 / 2 + 7 = 9 / 4 + 5 = 9.

What if?

Matthew's statement is never true: *If you subtract an even number from another even number the answer is an odd number* (the answer is always an even number), e.g. 4 – 2 = 2 / 6 – 4 = 2 / 8 – 2 = 6.

Dylan's statement is always true: *If you find the difference between an even number and an odd number the answer is an odd number*, e.g. 3 – 2 = 1 / 8 – 5 = 3 / 6 – 3 = 3.

Alice's statement is always true: *If you subtract an odd number from another odd number the answer is an even number*, e.g. 3 – 1 = 2 / 5 – 3 = 2 / 7 – 3 = 4.

Spot the relation (p.38)

Challenge

Possible calculations include:

9 + 7 = 16

9 + 17 = 26 / 17 + 9 = 26

19 + 7 = 26 / 7 + 19 = 26

19 + 17 = 36 / 17 + 19 = 36

90 + 70 = 160 / 70 + 90 = 160

Pupils' explanations will vary, depending on their depth of understanding. However, they should refer to the following. Use your professional judgement when assessing pupils' reasoning.

The calculation 7 + 9 = 16 (and 9 + 7 = 16) can be used to help work out the answers to other larger calculations, using combinations of one- and two-digit numbers, including multiples of 10.

What if?

Possible calculations include:

16 – 7 = 9 / 16 – 9 = 7

26 – 17 = 9 / 26 – 9 = 17

26 – 7 = 19 / 26 – 19 = 7

36 – 17 = 19 / 36 – 19 = 17

160 – 70 = 90 / 160 – 90 = 70

Pupils' explanations will vary depending on their depth of understanding. However, they should refer to the following. Use your professional judgement when assessing pupils' reasoning.

- The same set of three numbers can be used to make four related calculations: two addition and two subtraction.
- Addition and subtraction are inverse operations.

12 (p.39)

Challenge

2 × 6 = 12 / 6 × 2 = 12	12 ÷ 2 = 6 / 12 ÷ 6 = 2
3 × 4 = 12 / 4 × 3 = 12	12 ÷ 3 = 4 / 12 ÷ 4 = 3
1 × 12 = 12 / 12 × 1 = 12	12 ÷ 1 = 12 / 12 ÷ 12 = 1

Pupils' explanations will vary, depending on their depth of understanding. However, they should refer to the following. Use your professional judgement when assessing pupils' reasoning.

- Some understanding of the commutative law as it applies to multiplication.
- Some understanding of the inverse relationship between multiplication and division.

What if?

2 × 10 = 20 / 10 × 2 = 20	20 ÷ 2 = 10 / 20 ÷ 10 = 2
5 × 4 = 20 / 4 × 5 = 20	20 ÷ 5 = 4 / 20 ÷ 4 = 5
2 × 12 = 24 / 12 × 2 = 24	24 ÷ 2 = 12 / 24 ÷ 12 = 2
3 × 8 = 24 / 8 × 3 = 24	24 ÷ 3 = 8 / 20 ÷ 8 = 3
6 × 4 = 24 / 4 × 6 = 24	24 ÷ 6 = 4 / 24 ÷ 4 = 6

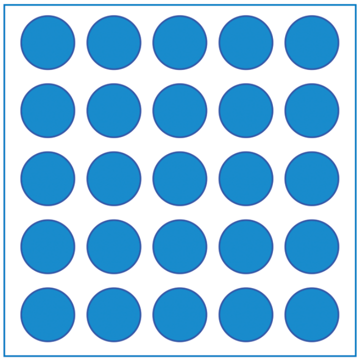
Describing 24 (p.40)

Challenge

4 × 5 + 5 = 24 does not describe the array.

Pupils' explanations will vary, depending on their depth of understanding. However, they may include a diagram similar to the following. Use your professional judgement when assessing pupils' reasoning.

4 × 5 + 5 = 25



What if?

Number sentences may include the following:

4 × 8 = 32 / 8 × 4 = 32

32 ÷ 4 = 8 / 32 ÷ 8 = 4

2 × 8 + 2 × 8 = 32 / 8 × 2 + 8 × 2 = 32

$5 \times 4 + 4 + 4 + 4 = 32$

$5 \times 4 + 2 \times 4 + 4 = 32$

$8 + 8 + 8 + 8 = 32$

$4 + 4 + 4 + 4 + 4 + 4 + 4 + 4 = 32$

What's the number sentence? (p.41)

Challenge

Pupils' number sentences will vary, however they may include the following:

Alice: 9 + 9 = 18 / 9 × 2 = 18 / 18 ÷ 2 = 9

Anushka: 4 + 4 + 4 + 4 = 16 / 4 × 4 = 16 / 16 ÷ 4 = 4

Matthew: 10 + 10 + 10 = 30 / 10 × 3 = 30 / 30 ÷ 3 = 10

Dylan: 5 + 5 + 5 + 5 + 5 + 5 + 5 = 35 / 5 × 7 = 35 / 35 ÷ 7 = 5

What if?

Representations will vary.

Missing numbers (p.42)

Challenge

$\boxed{3}$ 2   4

$\boxed{3} + \boxed{3} + \boxed{3} = 9$

$2 \times 4 = 8$

$4 \times \boxed{3} = 12$

$8 \div 2 = 4$

$\boxed{3} \times \boxed{3} = 9$

$12 \div \boxed{3} = 4$

$2 + 2 + 2 = 6$

$2 \times \boxed{3} = 6$

$4 + 4 + 4 = 12$

$6 \div 2 = \boxed{3}$

Pupils' explanations will vary.

What if?

Pupils' criteria for sorting will vary, however they may include the following:

$3 + 3 + 3 = 9$ / $3 \times 3 = 9$

$2 \times 4 = 8$ / $8 \div 2 = 4$

$4 \times 3 = 12$ / $4 + 4 + 4 = 12$ / $12 \div 3 = 4$

$2 + 2 + 2 = 6$ / $2 \times 3 = 6$ / $6 \div 2 = 3$

Same and different (p.43)

Challenge

Pupils' criteria for sorting will vary, depending on their depth of understanding. However, they may include the following. Use your professional judgement when assessing pupils' reasoning.

- $\frac{1}{4}$, $\frac{1}{3}$ and $\frac{1}{2}$ (unit / unitary fractions, i.e. they each have a numerator of 1)
- $\frac{2}{4}$ and $\frac{3}{4}$ (non-unit / non-unitary fractions, i.e. they each have a numerator greater than 1)
- $\frac{2}{4}$ and $\frac{1}{2}$ (fractions are a half)
- $\frac{1}{4}$, $\frac{1}{3}$ and $\frac{3}{4}$ (fractions are other than a half)
- $\frac{1}{4}$ and $\frac{1}{3}$ (fractions are smaller than a half)
- $\frac{3}{4}$ (fraction is greater than a half)
- $\frac{1}{4}$, $\frac{2}{4}$ and $\frac{3}{4}$ (fractions have a denominator of 4 – they are all quarters)
- $\frac{1}{3}$ and $\frac{1}{2}$ (fractions are not quarters)

What if?

Pupils' explanations will vary, depending on their depth of understanding. However they may include the following. Use your professional judgement when assessing pupils' reasoning.

- 
- $\frac{1}{4}$ of $8 = 2$
- $8 \div 4 = 2$
- $\frac{1}{2}$ is the same as dividing by 2 and $\frac{1}{3}$ is the same as dividing by 3.

Who's right? (p.44)

Challenge

Pupils' explanations will vary, depending on their depth of understanding. However, they may include the following. Use your professional judgement when assessing pupils' reasoning.

Dylan is right – $\frac{1}{4}$ is the smallest.

We compare fractions by looking at the denominators (the number on the bottom). A larger denominator means the whole is split into more equal parts. The more parts we split the whole into, the smaller the parts will be. So the larger the denominator, the smaller the fraction. In order from the smallest: $\frac{1}{4}$, $\frac{1}{3}$, $\frac{1}{2}$

What if?

Alice is right – $\frac{3}{4}$ is larger than $\frac{1}{4}$.

As both fractions have the same denominator (the number on the bottom), all we need to do to compare the fractions is look at the numerators (the number on the top). The numerator tells us how many parts of the whole we have. A larger numerator means more parts. So, $\frac{3}{4}$ is larger than $\frac{1}{4}$.

Anushka is not right – $\frac{2}{4}$ is not larger than $\frac{1}{2}$.

$\frac{2}{4}$ and $\frac{1}{2}$ are the same.

Who's wrong? (p.45)

Challenge

Pupils' explanations will vary, depending on their depth of understanding. However, they may include the following. Use your professional judgement when assessing pupils' reasoning.

Anushka is wrong – $\frac{1}{4}$ of £8 is £4.

$\frac{1}{4}$ of £8 is £2.

As $\frac{1}{4}$ is the same as dividing by 4, 8 divided by 4 is 2.

What if?

Assuming that pupils would prefer to have more money, then they should choose $\frac{3}{4}$ of £12, as $\frac{1}{2}$ of £12 is £6 and $\frac{3}{4}$ of £12 is £9.

How long? (p.46)

Challenge

biro – 15 cm, crayon – 12 cm, pencil – 17 cm and paintbrush – 29 cm

Pupils' comparisons will vary, but may involve comparisons expressed as follows:

12 cm < 15 cm / 15 cm > 12 cm

12 cm < 17 cm / 17 cm > 12 cm

12 cm < 29 cm / 29 cm > 12 cm

15 cm < 17 cm / 17 cm > 15 cm

15 cm < 29 cm / 29 cm > 15 cm

17 cm < 29 cm / 29 cm > 17 cm

crayon < biro / biro > crayon

crayon < pencil / pencil > crayon

crayon < paintbrush / paintbrush > crayon

biro < pencil / pencil > biro

biro < paintbrush / paintbrush > biro

pencil < paintbrush / paintbrush > pencil

What if?

Alice is right – the pencil is 5 cm longer than the crayon.

Pupils' explanations will vary, but may include the following:

- The pencil is 17 cm and the crayon is 12 cm, therefore the pencil is 5 cm longer than the crayon.

Pupils' statements will vary, but may include the following:

- The pencil is 2 cm longer than the biro.
- The paintbrush is 12 cm longer than the pencil.
- The crayon is 3 cm shorter than the biro.
- The crayon is 17 cm shorter than the paintbrush.

Fruit (p.47)

Challenge

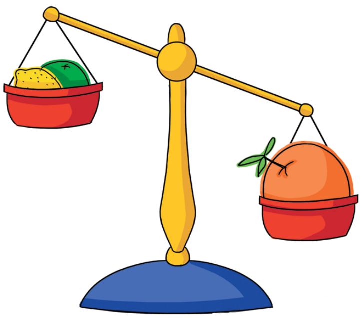
Pupils' statements will vary, depending on their depth of understanding. However, they may include the following. Use your professional judgement when assessing pupils' reasoning.

- One grapefruit has the same mass as four lemons.
- One grapefruit has four times the mass of a lemon.
- One lemon has a quarter of the mass of one grapefruit.
- If the grapefruit has a mass of 400 grams, then one lemon must have a mass of 100 grams.
- We know that one lemon has a quarter of the mass of one grapefruit, and a quarter of 400 grams is 100 grams.

What if?

If one apple has a mass that is half that of one grapefruit, and one grapefruit has a mass of 400 grams, then an apple has a mass of 200 grams.

If a lemon (100 grams) and an apple (200 grams) were placed on one side of the balance, then their total mass would be 300 grams (100 g + 200 g). Given that the grapefruit has a mass of 400 grams, then the balance might look like this:



Half a litre (p.48)

Challenge

Dylan does not have $\frac{1}{2}$ litre of juice. He has $\frac{3}{4}$ of a litre.

Pupils' explanations will vary, but may include the following:

- Dylan's bottle holds 1 litre but it is more than half full.

What if?

Neither Matthew nor Alice are right. Although Matthew has the larger bottle, he only has $\frac{1}{2}$ litre of juice in the bottle, and although Alice's bottle is the only full bottle, she too only has $\frac{1}{2}$ litre of juice.

What are the questions? (p.49)

Challenge

Pupils' questions will vary, but may include the following:

a) 60: How many minutes are there in an hour?

How many seconds are there in a minute?

b) 12: How many months are there in a year?

How many hours are there in half a day?

c) 24: How many hours are there in a day?

d) 30: How many days are there in April / June / September / November?

How many minutes are there in half an hour?

What if?

e) 7: How many days are there in a week?

f) 31: How many days are there in January / March / May / July / August / October / December?

g) 365: How many days are there in a year?

h) 15: How many minutes are there in quarter of an hour?

67p (p.50)

Challenge

Alice is right – there are a lot more than two or five different ways of make 67p, for example:

50p + 10p + 5p + 2p

20p + 20p + 20p + 5p + 2p

20p + 20p + 20p + 5p + 1p + 1p

(6 × 10p) + (7 × 1p)

(9 × 5p) + 20p + 2p

(33 × 2p) + 1p

67 × 1p

What if?

Pupils' explanations will vary, depending on their depth of understanding. However, they may include the following. Use your professional judgement when assessing pupils' reasoning.

Dylan is not right. It is not possible to make 67p using only silver coins. This is because 7p can only be made using silver and copper coins, or copper coins only, i.e.

silver and copper coins:

5p + 2p

5p + 1p + 1p

copper coins only:

2p + 2p + 2p + 1p

2p + 2p + 1p + 1p + 1p

2p + 1p + 1p + 1p + 1p + 1p

1p + 1p + 1p + 1p + 1p + 1p + 1p

Shape symmetry (p.51)

Challenge

Anushka is right. At least one line can be drawn on each shape that divides it into two matching halves.

What if?

Matthew is right. Polygons are shapes with straight sides, so the circle and semi-circle are not polygons.

What's my shape? (p.52)

Challenge

Alice could be thinking about a cone, cylinder or hemisphere because all of these three shapes have at least one circular face.

Anushka is thinking about a cube.

Dylan could be thinking about either a triangular-based pyramid (a tetrahedron) or a square-based pyramid, because each of these pyramids has four triangular faces.

What if?

Pupils' explanations will vary, depending on their depth of understanding. However, they may include the following. Use your professional judgement when assessing pupils' reasoning.

The sphere could be considered the 'odd one out' because it is the only 3-D shape with no edges and/or vertices because it has just one surface.

Other 3-D shapes chosen by the pupils and their justifications will vary. Use your professional judgement when assessing pupils' reasoning.

Ronnie the Robot (p.53)

Challenge

Dylan is not right. Ronnie should have been programmed to walk forward 3 blocks, make a quarter turn anticlockwise, walk forward 2 blocks, make a quarter turn clockwise and walk forward 3 blocks.

What if?

The shortest route that Ronnie could be programmed to walk home is by walking 8 blocks. Many routes are possible walking 9 blocks, including:

Walk forward 5 blocks. Make a quarter turn anticlockwise and walk forward 2 blocks. Then

make a quarter turn clockwise and walk forward 1 block.

Walk forward 1 block. Make a quarter turn anticlockwise and walk forward 2 blocks. Then

make a quarter turn clockwise and walk forward 5 blocks.

Many routes are possible if Ronnie has to stop off to refuel and then go to the mechanics on his way home. Accept any route given by the child as long as Ronnie passes the Fuel block and the Mechanics block on his way home. For example:

Walk forward 1 block.

Make a quarter turn anticlockwise and walk forward 2 blocks.

Make a quarter turn clockwise and walk forward 3 blocks.

Make a quarter turn clockwise and walk forward 2 blocks.

Make a quarter turn anticlockwise and walk forward 1 block.

Make a quarter turn anticlockwise and walk forward 2 blocks.

Make a quarter turn clockwise and walk forward 1 block.

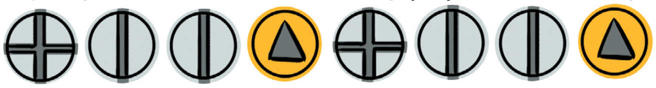
Production line (p.54)

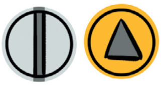
Challenge

The next screw to come out of the machine and along the conveyor belt will be: 

The screw that comes out of the machine after that will be: 

Pupils' explanations will vary, depending on their depth of understanding, however they may include the following. Use your professional judgement when assessing pupils' reasoning.

The pattern can be shown as: 

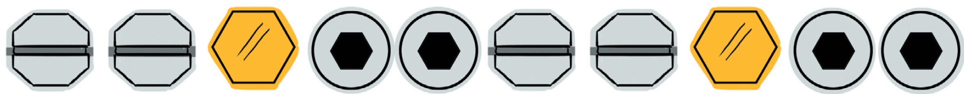
The screw that is to the left of  is another  and the screw that is to the left of that is 

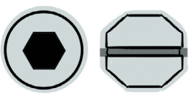
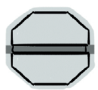
What if?

The screw that has just fallen into the tub is: 

The screw that fell into the tub before that one is: 

Pupils' explanations will vary depending on their depth of understanding, however they may include the following. Use your professional judgement when assessing pupils' reasoning.

The pattern can be described as: 

The screw that is to the right of  is another  and the screw that is to the right of that is 

Different data (p.55)

Challenge

Pupils' answers will vary. Some sample answers are provided below for guidance. Use your professional judgement when assessing pupils' responses to open-ended questions and their reasoning.

The same:

- The same four types of fruit are used.
- Two pupils prefer mangos.

Different:

- The Class 2A results are displayed in a block graph and the Class 2B results displayed in a pictogram.
- In Class 2A four pupils prefer oranges and in Class 2B three pupils prefer oranges.
- In Class 2A three pupils prefer apples and in Class 2B four pupils prefer apples.
- In Class 2A six pupils prefer bananas and in Class 2B five pupils prefer bananas.
- The Class 2A block graph shows 15 results and the Class 2B pictogram shows 14 results.

What if?

The data in the table is the same as in the pictogram. So Class 2C's results are the same as Class 2B's.

Different:

- The Class 2A results are displayed in a block graph, the Class 2B results displayed in a pictogram and the Class 2C results in a table.

Using and applying mathematics in real-world contexts

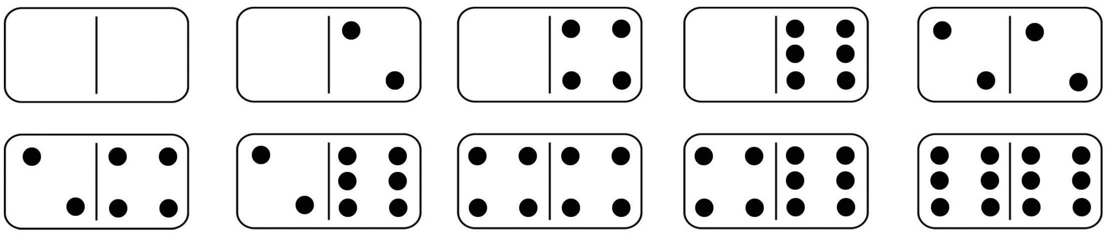
Sorting dominoes (p.56)

Challenge

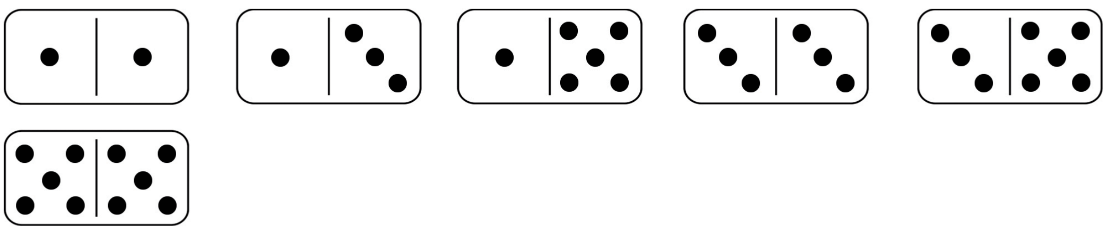
NOTE:

Zero is considered an even number because any number that can be divided by two to create another whole number is even. Zero satisfies this requirement because if you halve zero, you get zero. Zero also lies between two odd numbers – minus one and one – another requirement of an even number.

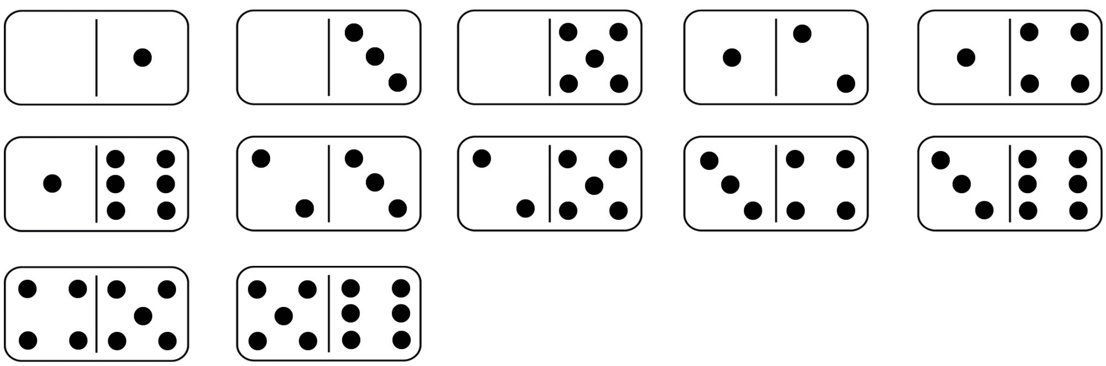
Even number of dots at both ends (10 dominoes)



Odd number of dots at both ends (6 dominoes)



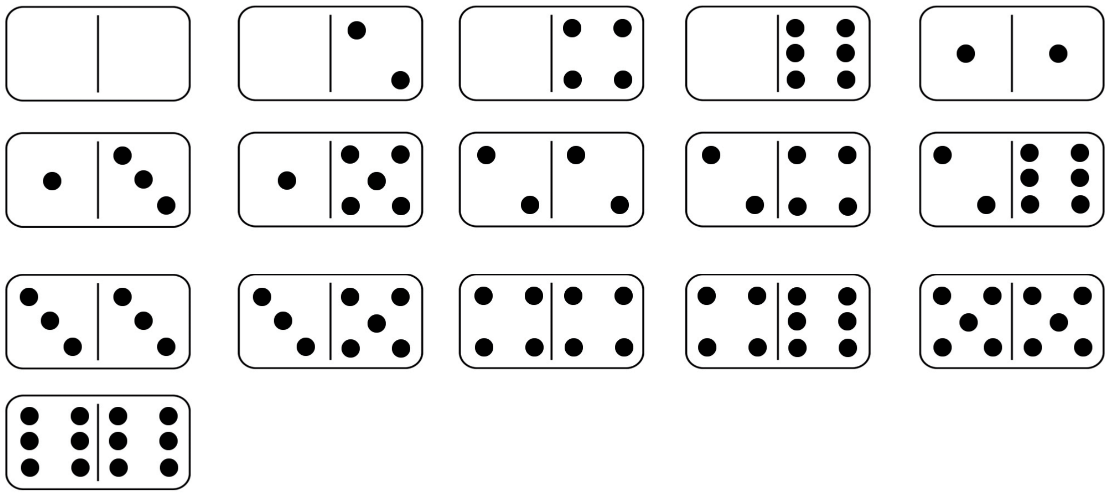
Even number of dots at one end and an odd number of dots at the other end (12 dominoes)



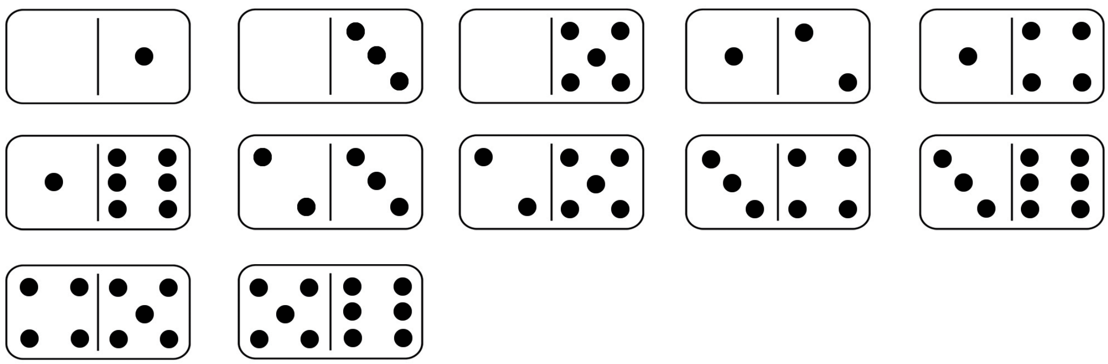
The group with an even number of dots at one end and an odd number of dots at the other end is the largest.

What if?

Dominoes with an even total number of dots (16 dominoes)



Dominoes with an odd total number of dots (12 dominoes)



The results show that:

even + even = even

odd + odd = even

odd + even = odd / even + odd = odd

Pupils' sorting criteria will vary.

Visitors (p.57)

Challenge/What if?

Results of the challenge will vary.

Phone numbers (p.58)

Challenge/What if?

Results of the challenge will vary.

Clever birthday (p.59)

Challenge

There are numerous ways of making all of the numbers from 1 to 20. One possible calculation for each number is shown below:

$1 = 2 - 1$	$11 = 5 + 4 + 2$
$2 = 4 \div 2$	$12 = 2 \times 5 + 1 + 1$
$3 = 2 + 1$	$13 = 2 \times 5 + 1 + 1 + 1$
$4 = 5 - 1$	$14 = 2 \times 5 + 4$
$5 = 4 + 1$	$15 = 5 \times 4 - 2 - 1 - 1 - 1$
$6 = 5 + 1$	$16 = 5 \times 4 - 2 - 1 - 1$
$7 = 5 + 2$	$17 = 5 \times 4 - 2 - 1$
$8 = 2 \times 4$	$18 = 5 \times 4 - 2$
$9 = 5 + 4$	$19 = 5 \times 4 - 1$
$10 = 2 \times 5$	$20 = 5 \times 4$

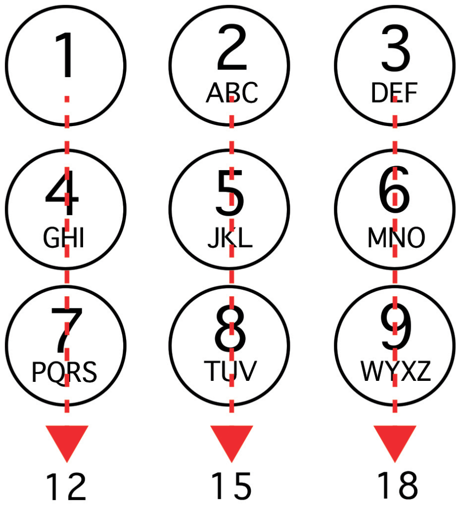
What if?

Pupils' calculations will vary depending on their date of birth.

Phone pad patterns (p.60)

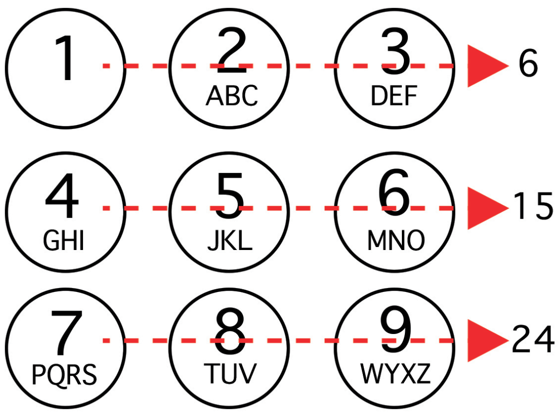
Challenge

Pupils' explanations will vary depending on their depth of understanding. However, they should refer to the following. Use your professional judgement when assessing pupils' reasoning.



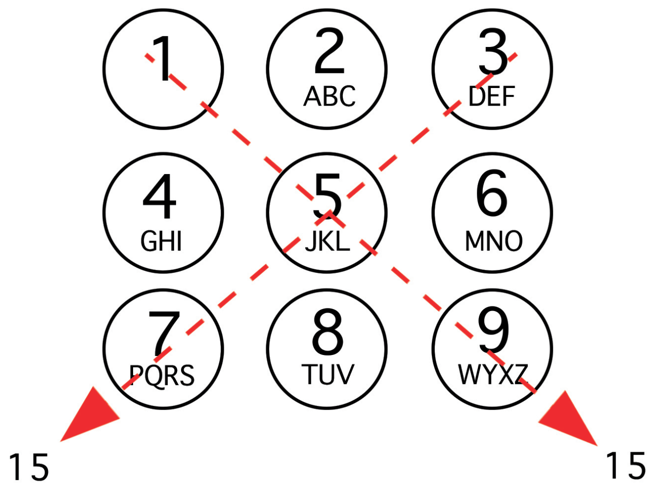
Adding the three digits in each column:

- Working left to right, consecutive column totals increase by 3.
- The sum of each column is a multiple of 3.



Adding the three digits in each column:

- Working top to bottom, consecutive row totals increase by 9.
- The sum of each row is a multiple of 3.

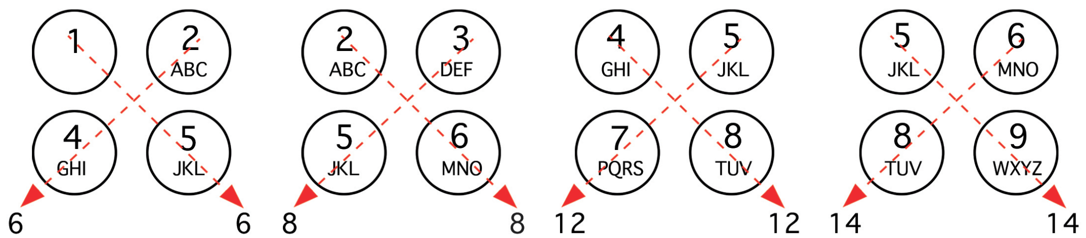


Adding the three digits in each diagonal:

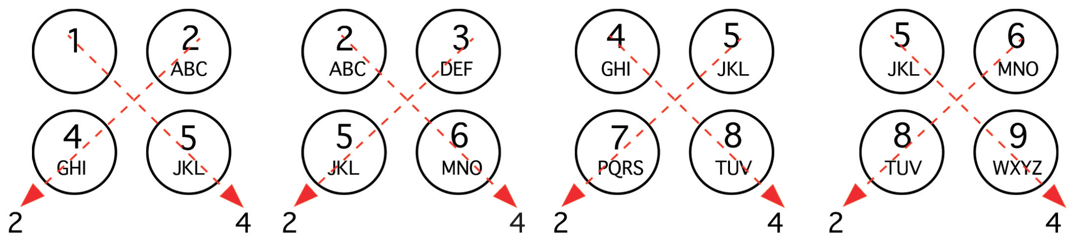
- Both totals equal 15.
- The sum of each diagonal is a multiple of 3.

What if?

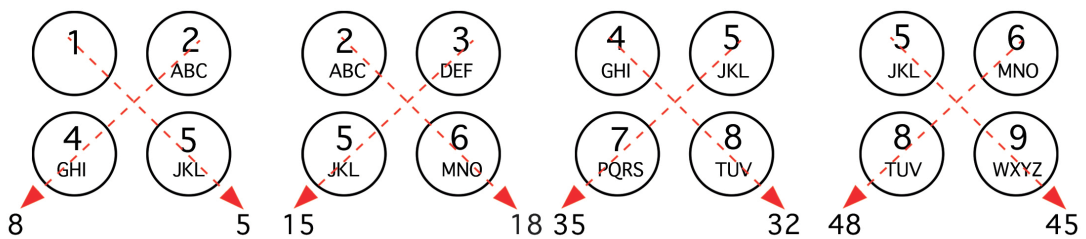
The sum of the digits in each diagonal in a 2 by 2 square is always the same.



The differences between the digits in each diagonal in a 2 by 2 square are always 2 and 4.



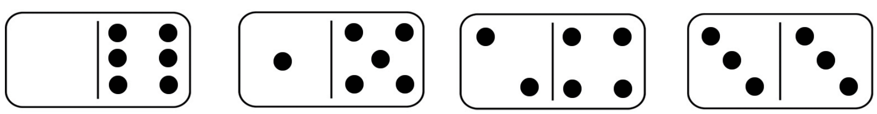
The difference between the products of the two digits in each diagonal in a 2 by 2 square is always 3.



Calculating dominoes (p.61)

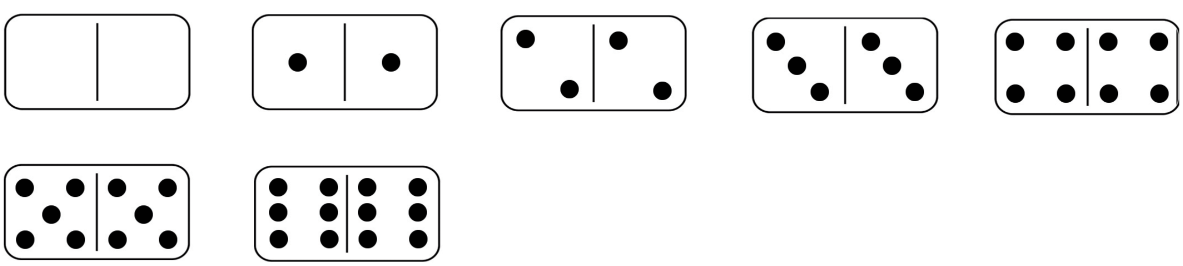
Challenge

The most common total is 6 (four dominoes):

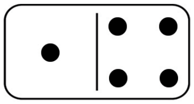
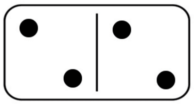


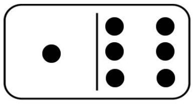
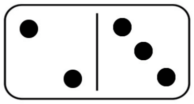
What if?

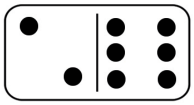
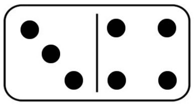
The most common difference is 0 (seven dominoes):



4, 6 and 12 are the most common products (two dominoes each):

4:  

6:  

12:  

Stamps (p.62)

Challenge/What if?

The calculations below will vary depending on the current value of the four different 1st and 2nd Class stamps.

From 27th March 2017, 1st and 2nd Class stamp prices are:

1st Standard letter: 65p

1st Large letter: 98p

2nd Standard letter: 56p

2nd Large letter: 76p

The following are the ways of making each of the amounts using the fewest stamps and based on the four different 1st and 2nd Class stamp values above.

£1.22 = £1 + 20p + 2p or 1st Standard letter + 2nd Standard letter + 1p

£1.74 = 1st Large letter + 2nd Large letter

£1.30 = 2 × 1st Standard letter

£1.58 = £1.57 + 1p

£1.66 = 1st Standard letter + £1 + 1p or 2nd Standard letter + £1 + 10p

£1.86 = 2nd Large letter + £1 + 10p

Body links (p.63)

Challenge

The size (circumference) of your wrist is the same as the size (circumference) made by joining the tip of your middle finger to the tip of your thumb.

The size (circumference) of your wrist is twice the size (circumference) of your thumb.

The size of your index finger is the same as the distance from the tip of your nose to your chin.

What if?

The size (circumference) of your neck is twice the size (circumference) of your wrist.

The size (circumference) of your waist is twice the size (circumference) of your neck.

The size (circumference) of your fist is the same as the length of your foot.

Walking (p.64)

Challenge/What if?

Results of the challenge will vary.

Holding hands (p.65)

Challenge

Results of the challenge will vary. However, one method of working out how many pupils holding hands would be needed to reach all the way around the school would be to:

- measure the total length of a certain number of pupils all holding hands (ideally two, five or ten pupils*)
- measure the distance around the school (perhaps using a trundle wheel)
- upscale the length for the two, five or ten pupils until the distance around the school is reached.

NOTE: *Using two, five or ten pupils will allow pupils to use and apply their knowledge of counting on in steps of 2, 5 or 10 and/or 2, 5 and 10 multiplication facts.

What if?

Results of the challenge will vary.

Balls (p.66)

Challenge/What if?

Results of the challenge will vary.

Cooked and uncooked (p.67)

Challenge

The weight of a boiled egg is the same as a raw egg.

What if?

Results of the challenge will vary. However, depending on the amount of water used and the length of cooking time, brown rice approximately doubles in mass (and volume) after cooking, and white rice approximately triples in both volume and mass after cooking.

Cooked pasta is roughly one and a half to two times the mass (and volume) of uncooked pasta.

Tinned fruit (p.68)

Challenge

Results of the challenge will vary. However, pupils' answers should refer to both mass (fruit) and volume/capacity (liquid) and their corresponding units of measure, i.e. kg/g and litres/ml.

What if?

It is not possible to say that there is more juice than fruit, or vice versa, because the units of measure used are different, i.e. you are comparing mass (grams) with volume/capacity (litres or millilitres), or vice versa.

Orange drink (p.69)

Challenge

Each 200 ml plastic cup holds 40 ml of orange squash and 160 ml of water.

For a group of six pupils, using the given ratio of one part squash to four parts water, a total of 240 ml of orange squash and 960 ml of water would be needed to give each pupil a cup of orange drink.

What if?

Results of the challenge will vary.

TV times (p.70)

Challenge/What if?

Results of the challenge will vary.

Paper clips (p.71)

Challenge

Results of the challenge will vary. However, most pupils should be able to link between six and ten paper clips together in one minute.

What if?

Results of the challenge will vary.

Sharing £12 (p.72)

Challenge

Pupils' answers will vary depending on their depth of understanding of fractions. However, they should include $\frac{1}{2}$, $\frac{1}{3}$, $\frac{1}{4}$ and $\frac{3}{4}$ fractions. Use your professional judgement when assessing pupils' reasoning.

Possible ways of sharing £12 using the above fractions are shown in the table below.

Number of pupils	Fraction	Money
2	$\frac{1}{2} + \frac{1}{2}$	£6 + £6
2	$\frac{3}{4} + \frac{1}{4}$	£9 + £3
3	$\frac{1}{3} + \frac{1}{3} + \frac{1}{3}$	£4 + £4 + £4
3	$\frac{1}{2} + \frac{1}{4} + \frac{1}{4}$	£6 + £3 + £3
4	$\frac{1}{4} + \frac{1}{4} + \frac{1}{4} + \frac{1}{4}$	£3 + £3 + £3 + £3

Not all of Mrs Edwards' ways of sharing £12 are fair, as she does not always share the money into equal amounts, e.g. when sharing between two pupils: $\frac{3}{4} + \frac{1}{4}$ or when sharing between three pupils: $\frac{1}{2} + \frac{1}{4} + \frac{1}{4}$.

What if?

Possible ways of sharing £24 using the above fractions are shown in the table below.

Number of pupils	Fraction	Money
2	$\frac{1}{2} + \frac{1}{2}$	£12 + £12
2	$\frac{3}{4} + \frac{1}{4}$	£18 + £6
3	$\frac{1}{3} + \frac{1}{3} + \frac{1}{3}$	£8 + £8 + £8
3	$\frac{1}{2} + \frac{1}{4} + \frac{1}{4}$	£12 + £6 + £6
4	$\frac{1}{4} + \frac{1}{4} + \frac{1}{4} + \frac{1}{4}$	£6 + £6 + £6 + £6

If pupils use the same fraction combinations for sharing £24 as they do for £12, then they should notice that the amount of money that each child receives when sharing £24 is double the amount they received when sharing £12.

€100 to spend! (p.73)

Challenge/What if?

Results of the challenge will vary.

Supermarkets (p.74)

Challenge

Results of the challenge will vary, so use your professional judgement when assessing pupils' reasoning. However, in terms of which two shapes are the most popular for packaging, pupils should identify cuboids and cylinders (shapes that also have symmetry). The main reason for this is because cuboids, and to a slightly lesser extent cylinders, can be packed more tightly together on shelves, thereby reducing the amount of unusable shelf space. However, they also make it easier to display and read all the important information concerning the item, e.g. name, weight, ingredients, price and so on, and they are also easy to carry.

What if?

Results of the challenge will vary, so use your professional judgement when assessing pupils' reasoning. However, pupils should identify that most rounded fruit will have symmetry (if not perfect symmetry). They may also identify the fact that when many fruit and vegetables are cut in half, they also show symmetry.

Animal shapes (p.75)

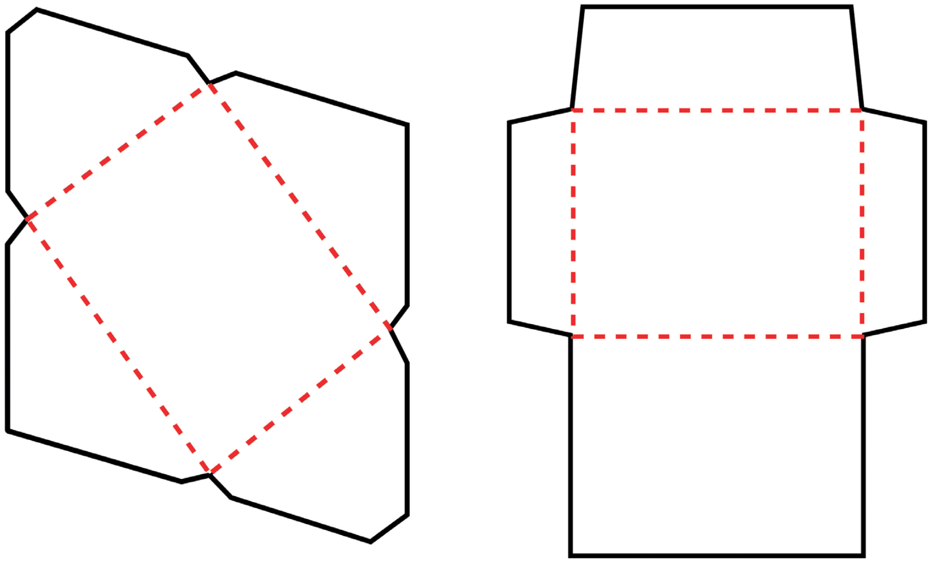
Challenge/What if?

Results of the challenge will vary.

Envelopes (p.76)

Challenge

Results of the challenge will vary. However, possible templates may look something similar to the following:



What if?

Results of the challenge will vary.

Apple patterns (p.77)

Challenge/What if?

Results of the challenge will vary.

Breakfast (p.78)

Challenge/What if?

Results of the challenge will vary.

Class pet (p.79)

What if?

Results of the challenge will vary. However, pupils should construct a simple pictogram, block diagram or table in order to justify their conclusions.