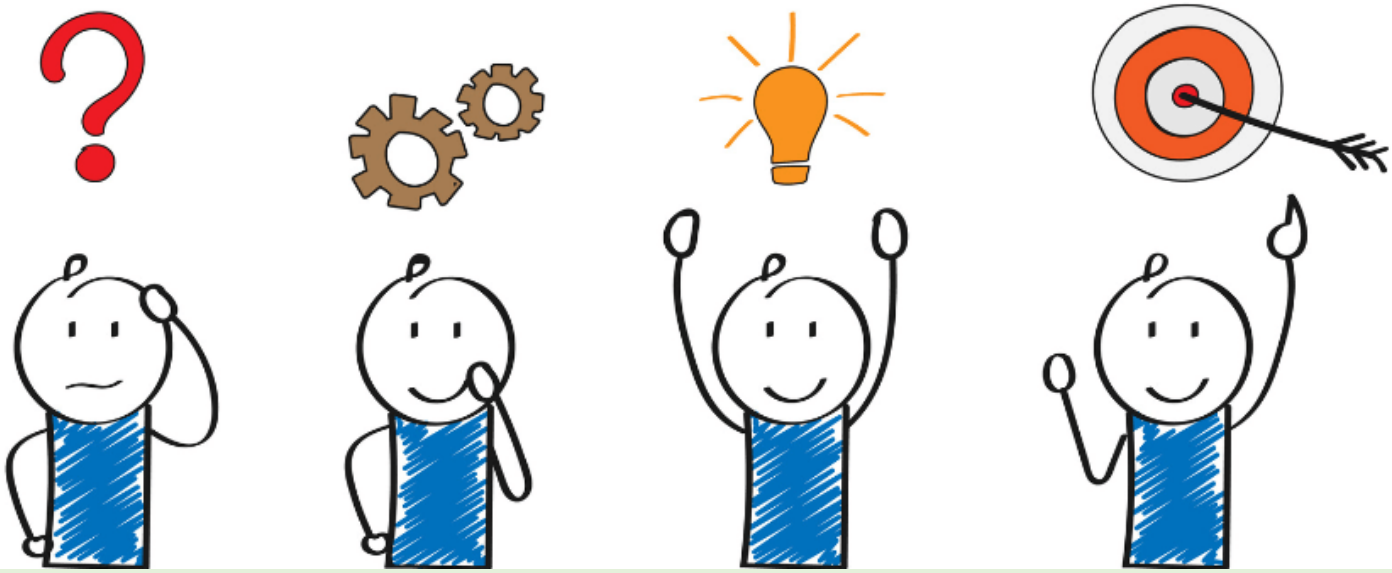
Reasoning in maths at Muschamp



Policy and Progression Document

National curriculum in England: mathematics programmes of study

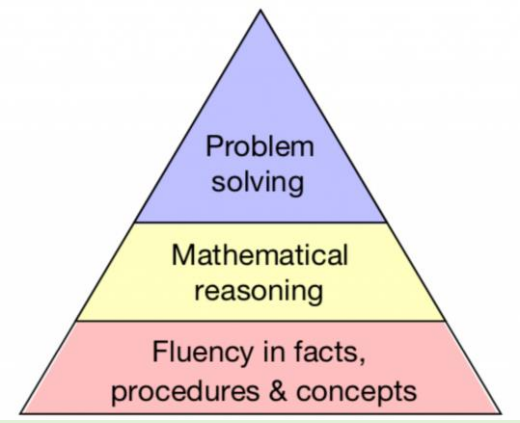
Aims

The national curriculum for mathematics aims to ensure that all pupils:

• become fluent in the fundamentals of mathematics, including through **varied and frequent practice with increasingly complex problems over time**, so that pupils develop conceptual understanding and the ability to recall and apply knowledge rapidly and accurately.

• **reason mathematically by following a line of enquiry, conjecturing relationships and generalisations, and developing an argument, justification or proof using mathematical language.**

• **can solve problems by applying their mathematics to a variety of routine and non-routine problems with increasing sophistication, including breaking down problems into a series of simpler steps and persevering in seeking solutions.**



Spoken language

The national curriculum for mathematics reflects the importance of spoken language in pupils' development across the whole curriculum – cognitively, socially and linguistically. **The quality and variety of language that pupils hear and speak are key factors in developing their mathematical vocabulary and presenting a mathematical justification, argument or proof**. **They must be assisted in making their thinking clear to themselves as well as others**, and teachers should ensure that pupils build secure foundations by using discussion to probe and remedy their misconceptions.

What is reasoning in maths?

Reasoning is the ability to explain how and why.

- **Why have you arrived at the answer they have?**
- **What is the process that brought you to this conclusion?**
- **Why did you choose to take the route you took to reach that answer?**
- **How can you be confident your answer is correct?**
- **And more importantly, can you prove it?**

Reasoning is about using what you already know to help you deduce, reason or predict what will happen and the best way to go about facing a problem, with this knowledge in mind. It can be as simple as…

'I have to work out 6 + 5. I know 5 + 5 is 10. 6 is 1 more than 5, so my answer will be 1 more than 5 + 5.'

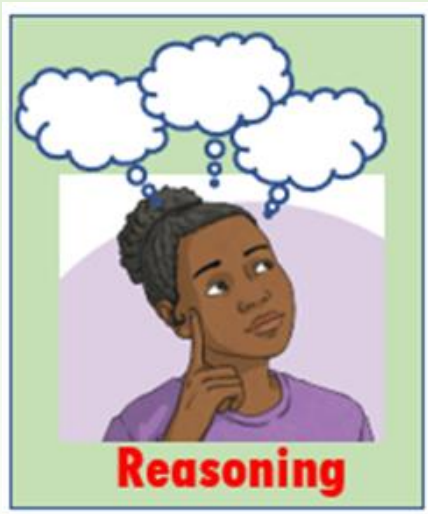
- Reasoning is a type of strategic thinking.
- Reasoning doesn't always mean getting the right answer. Reasoning in maths is the exciting bridge that allows students to come up with a reasonable strategy to solve a problem.
- Reasoning is explaining how and why they have worked the way they have.

Working with reasoning in mind helps to develop a deeper level of mathematical understanding.
Students are able to come up with their own strategies and solutions and work in a way that favours their strengths in understanding. This helps to build more resilient and autonomous learners.

It's our job to encourage students to make the necessary links and connections between numbers and processes.

What we want to see at Muschamp…

- Reasoning evident at some point in every lesson.
- The reasoning process forms part of the adult think aloud to support metacognition.
- Reasoning to be part of the learning partner work/discussions.
- Evidence of reasoning in books, once a week.
- Reasoning is for all abilities in all year groups.
- Reasoning not ‘reserved’ for the ‘more able’.
- Reasoning to be used throughout a topic and not only towards the end of a topic.
- Reasoning used at any point during a lesson. It shouldn’t only be used as a ‘challenge’.
- Correct use of vocabulary is essential. This needs to be modelling and expected.



Speak like a mathematician

Avoid over complicating things and also mistaking reasoning, for problem solving.

Find the product.

1. 5,747 × 6	2. 4,970 × 4	3. 4,397 × 4
4. 8,949 × 9	5. 5,042 × 3	6. 7,995 × 6
7. 5,984 × 2	8. 6,879 × 3	9. 3,933 × 5
10. 3,420 × 4	11. 4,762 × 7	12. 8,201 × 9
13. 4,332 × 6	14. 6,342 × 4	15. 7,673 × 2

Use the digits, 2, 3, 4, 5 and 6 to create a 4-digit by 1-digit multiplication (for example 3652 x 4)

You can only each digit once with each attempt.

You are trying to make...

1. **The largest possible product**
2. **The smallest possible product**
3. **The product closest to 15,000**

Show all your calculations.
Make it clear what part you are working on.

Consider the similarities and differences between these two tasks. The calculations generated will be really similar, but the 2nd task has so many more reasoning elements. There are also so many things wrong with the worksheet.

Resources to support reasoning…

Online resources to support reasoning…

https://www.ncetm.org.uk/classroom-resources/checkpoints/

https://www.twinkl.co.uk/teaching-wiki/reasoning-in-maths

https://www.ncetm.org.uk/classroom-resources/pm-reasoning-skills/

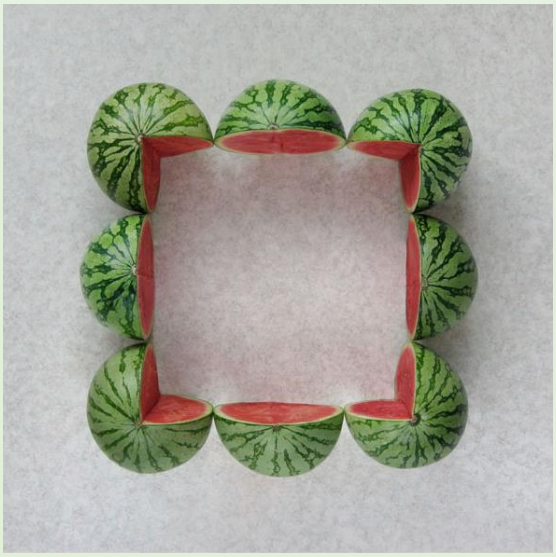
https://nrich.maths.org/reasoning

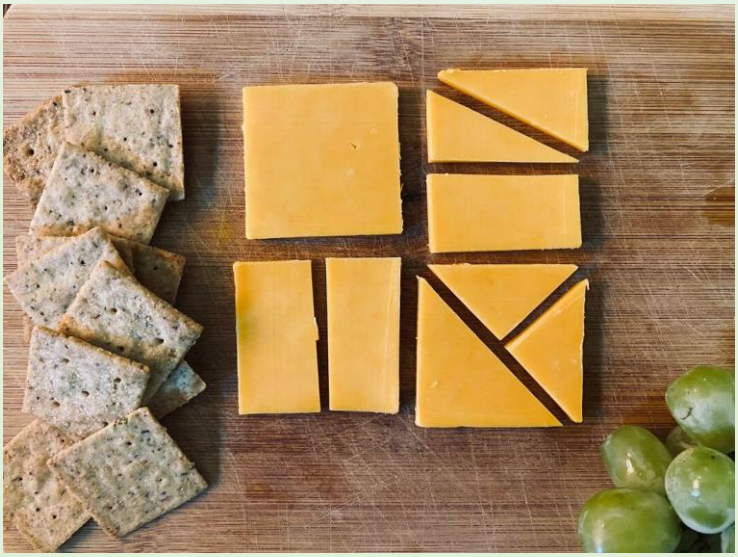
https://thirdspacelearning.com/blog/developing-reasoning-skills-maths-ks2/

G:\Shared drives\MPS-Muschamp Home\Maths\Progression in reasoning

Websites like Classroom Secrets and White Rose have lots – we don't have subscriptions, but you can easily find their resources online.

Using images as a starting point for talking about maths. Look at how easy and accessible these images would be, at all levels, to generate some high quality reasoning.





https://ntimages.weebly.com/photos.html

https://kristenacosta.com/number-talk-images/

Number and Place Value

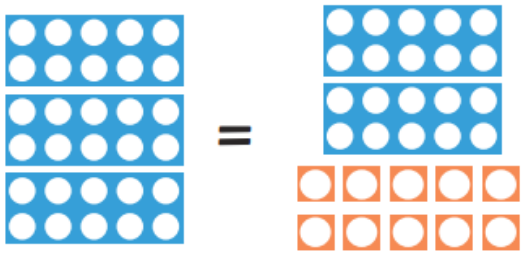
Spot the mistake:
5,6,8,9
What is wrong with this sequence of numbers?

True or False?
I start at 3 and count in threes. I will say 13?

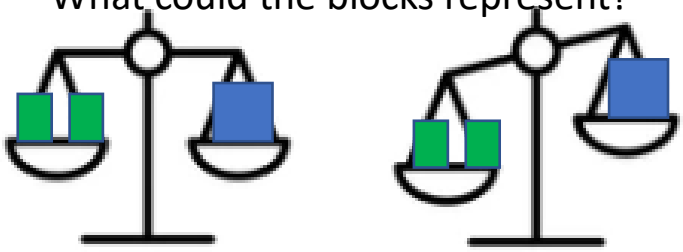
Do, then explain
835 535 538 388 508
If you wrote these numbers from the smallest, which number would be third? Explain how you ordered the numbers.

Li has made a sentence.

Do you agree? Can you explain what she has done? Can you make a similar sentence using equipment?



What could the blocks represent?



Which number is the odd one out?
Explain your reasons.

1330	1015
2941	3645

Reasoning - Is it true or false?

The numbers in this sequence increase by the same amount each time.

Write the missing numbers.

−11		1	7		19

Olivia is thinking of a number.

My number
- is greater than 236
- is less than 245
- has a 3 in the tens' place
- is an even number

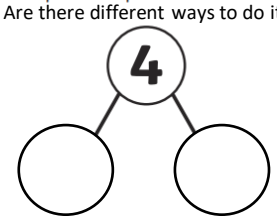
What number is Olivia thinking of?

Addition and Subtraction

Is it true that?

3 + 1 = 1 + 3?

Complete the part-whole model.
Are there different ways to do it?



Which number bond is the odd one out?

3 + 4 5 + 2 6 + 1 3 + 5

Explain your answer.

Always, sometimes, never…

If you add three numbers less than 10 the answer will be an odd number

Other possibilities

□ + □ + □ = 14

What single digit numbers could go in the boxes? How many different ways can you do this?

2. A box holds 760 pencils.

Andrew says,

369 pencils are already in the box. 390 pencils are added. That means the box is full.

Is he correct? Explain your answer.

Gran buys two raffle tickets at the fair.

She gives the children clues to guess the numbers on her tickets.

a) If I add 7 to my first number, the answer is 20.

b) If I subtract 15 from my second number, the answer is 5.

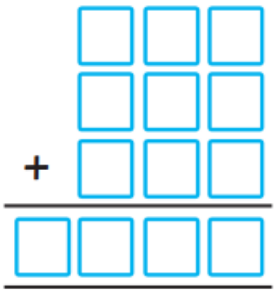
Can you work out the ticket numbers?

What did you do to work them out?

$$\begin{array}{r} \cancel{7}^{\,6}\,.\,6\,\cancel{6}^{\,16} \\ -\;5\,.\,5\,8 \\ \hline 1\,.\,1\,8 \end{array}$$

Explain what he has done wrong.

Use the digits 1 to 9 (once only) to make three 3-digit numbers. Your mission is to make the total as close to 1500 as you can.



Convince me

Three four digit numbers total 12435.
What could they be?
Convince me

A hall has 1,250 seats.

At 7 pm, 880 seats are filled.

At 8 pm, there are 40 empty seats.

How many seats were filled between 7 pm and 8 pm?

Multiplication and Division

Draw a picture or show using resources…

3 x 2 = 6

One group catches 20 fish. They want to put 5 in each jar so they can see them clearly.
Is Riley correct? Prove it!

Janet is counting in twos.
She counts the number 17.

Has she counted correctly?

How do you know?

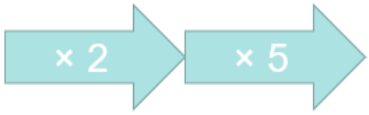
Prove It Which four number sentences link these numbers?
3, 5, 15? Prove it.

True or false? Explain your reasoning!

$2 \times 10 = 5 \times 4$

$2 \times 6 = 3 \times 5$

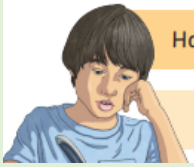
$5 \times 5 = 10 \times 3$



Explain why **every** number that comes out of this pair of function machines is a multiple of 10.

Daniel has written the factor pairs of 30.

0 and 30	2 and 15	3 and 10	5 and 6	6 and 5



Has he made any mistakes?

Explain your reasoning.

My number is between 15 and 25 and is divisible by 4.

Find all the possibilities.

Draw a pictorial representation to support your answer.

How close can you get?

Using the digits 3, 4, 6 and 7 in a 3 x 1 digit calculation…

What is the largest product?

What is the smallest product?

How close can you get to 4500?

Always, sometimes, never?

When you multiply a whole number by 9, the sum of its digits is also a multiple of 9

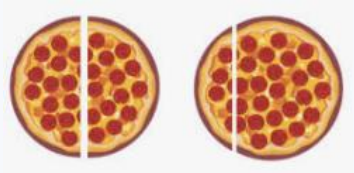
Mrs Mills has **940** seeds to plant into trays.

She plants **12** seeds in each tray.

The last tray is not full.

What **fraction** of the last tray is filled?

Fractions (inc. decs and %)



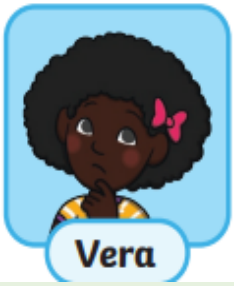
Make a playdoh pizza – can you cut it in half and share with a friend? Would both these be 'fair' and 'equal'?

True or false?

Sharing 8 apples between 4 children means each child has 1 apple.

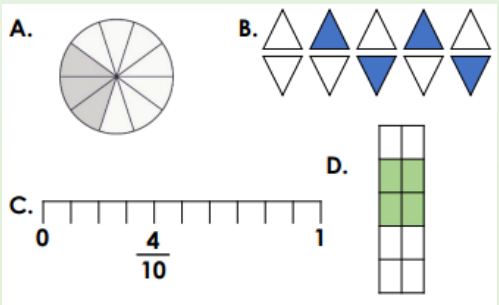
Spot the mistake

7, 7 ½ , 8, 9,
8 ½, 8, 7, 6 ½, … and correct it



Vera thinks of a number.
One-quarter of her number is 4.
What is her number?

Odd one out

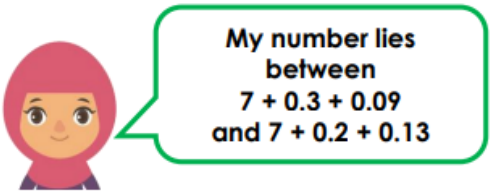


Explain how you know…

If a fraction is more than a half but less than a whole (draw an image to help you prove it)

Fill in the Blanks

$\frac{1}{3}$ of 60 = $\frac{1}{4}$ of ☐



What number is Sunita thinking of? Is there more than one possible answer?

Do, then explain

Circle each decimal which when rounded to one decimal place is 6.2. 6.32 6.23 6.27 6.17
Explain your reasoning

Undoing

I find 20% of a number and the answer is 14. What number did I start with?

True or false?

25% of 23km is longer than 0.2 of 20km. Convince me.

A class votes for a captain.

Three-quarters of the class vote for Sam.

The remaining 7 pupils vote for Alex.

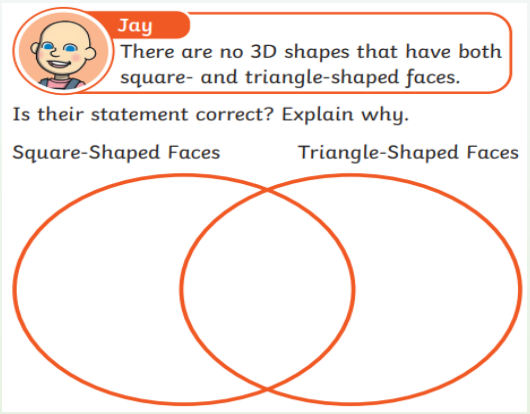
How many pupils are in the class?

Geometry/Properties of Shapes

What's the same, what's different?

Find a rectangle and a triangle.
Tell me one thing that's the same and one thing that is different about them.

Can you post the small shapes through the matching big shape?



All possibilities

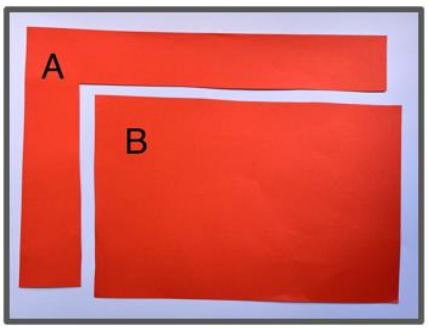
Aisha draws around the faces of a 3D shape to create these 2D shapes. What 3D shapes could she have used?

Visualising

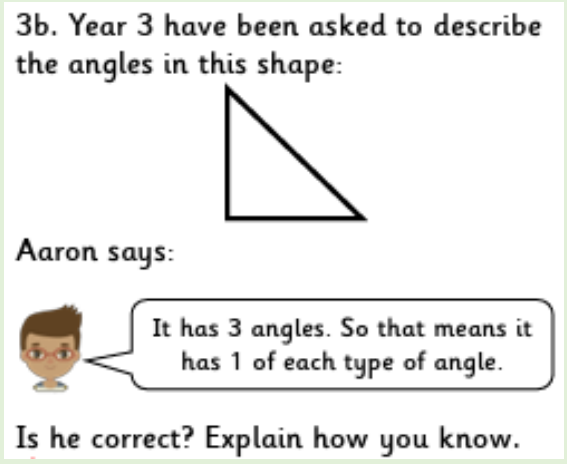
I am thinking of a 3D shape which has faces that are triangles and squares. What could my shape be?

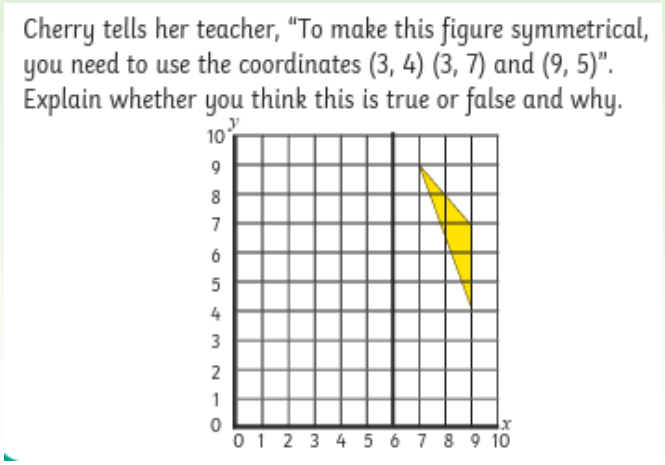
Convince me

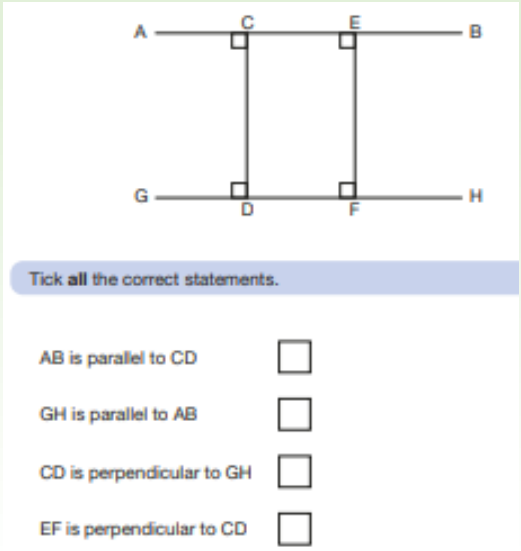
What is the angle between the hands of a clock at four o clock? At what other times is the same size angle?

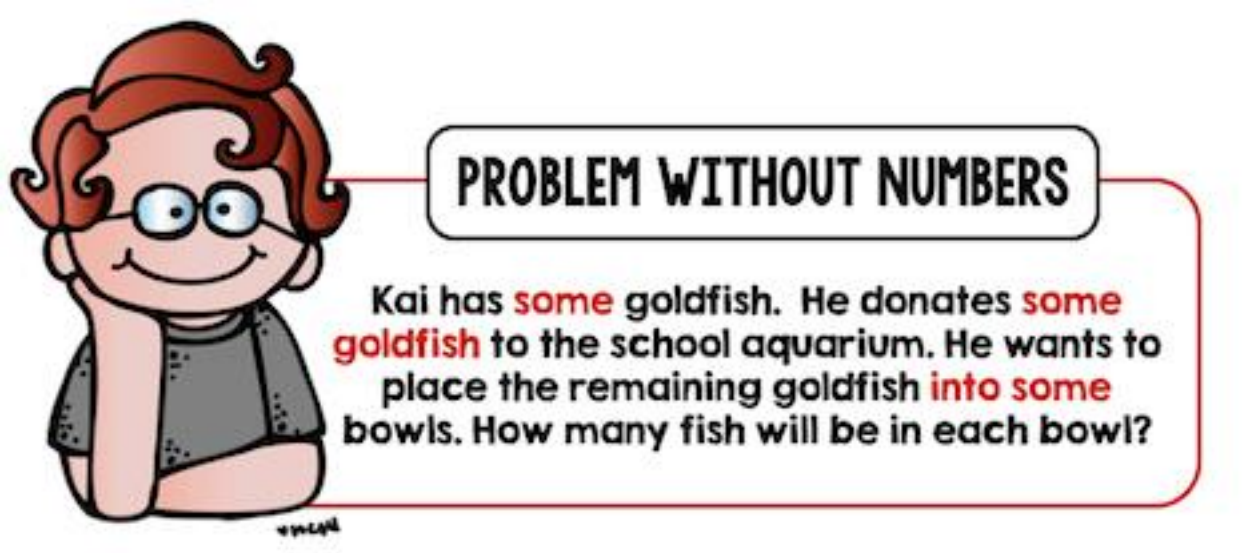


A sheet of paper is cut in two. Which of the two pieces has the longest perimeter, A or B? Why?









By removing the numbers, it means that the focus for discussion is really around what would need doing. It removes that opportunity to try and move straight to the calculation.

Children can then try to include numbers to see how their rationale would work.

Graphs with no values/headings, can be used to generate lots of conversation/reasoning. The children need to really understand what the trends might be showing and then apply this to real life situations.