



DIGIT DETECTIVE

Find the digit to replace the ? mark that makes this equation true:

$$12 + ? = 19$$

Each ? is a missing digit from 0 to 9 either the same or different digits.

$$? + 8 = 2?$$

$$2? + 4 = 1?$$

$$33 + ? = 4?$$

What do you notice?

You are a detective and you have to discover what digits the question marks stand for.

They can be any digit from 0 to 9.

They can be the same digit or different digits.

How will you find the missing digits?

What do you notice?

How many solutions are there to the calculations?

What clues did you use to help you work out your answers?

Explain why this happens?

Now find the missing digits in these calculations:

(a) $3?6 + 5? = 383$ (b) $8?3 - ?? = 815$

What clues did you use? Explain how you solved the puzzles.

In the next two puzzles each of the digits must be different.

(c) Find the largest possible total for $?? + ?? =$

Explain why it is the largest.

Find the smallest possible total and explain?

(d) What about $?? \times ??$

(e) Now find the missing digit in this division: $816 \div ? = 272$

HELP

Detectives often work with a partner or a group so you might find it helps to work together with other people on these cases and help each other.

NEXT

$$\begin{array}{r} \text{○} \text{○} \\ \text{◇} \text{◇} \\ + \text{□} \text{□} \\ \hline \text{○} \text{◇} \text{□} \end{array}$$

Find the Numbers

The 3 symbols, green circle, blue rhombus and pink square, stand for 3 different digits that make the addition sum correct.

Again you need to be a digit detective and find the clues that will help you to solve this puzzle.

<https://aiminghigh.aimssec.ac.za/years-6-7-find-the-numbers/>

NOTES FOR TEACHERS

SOLUTION

$? + 8 = 2?$ is impossible.

There are no solutions because the largest number you can get from $? + 8 = 9 + 8 = 17$ which is less than 20.

$2? + 4 = 1?$ is impossible.

There are no solutions because $2?$ has to be at least 20 and by adding 4 you get a number greater than 20.

$33 + ? = 4?$ has 3 solutions.

You do not get a solution if you add any digit less than 7 to 33 because you get an answer less than 40.

$$33 + 7 = 40$$

$$34 + 8 = 41$$

$$35 + 9 = 42$$

(a) $3?6 + 5? = 383$ has the solution

$$326 + 57 = 383$$

The clues are that to get the units digit 3 you must add 7 to 6.

Then $7 + 6 = 13$ so you are looking for $1 + 5 + ? = 8$ to find the tens digit.

(b) $8?3 - 7? = 815$ has the solutions

$$893 - 78 = 815$$

The clues are that you must subtract a number from 13 to get the units digit 5.

The inverse operation $815 + 78$ gives the number 893.

(c) The largest total for $?? + ?? =$ is

$$97 + 86 = 183 \text{ or}$$

$$96 + 87 = 183$$

To get the largest total you need to make the tens digits as large as possible and then make the units digits as large as possible choosing from the remaining digits.

The smallest is

$$10 + 23 = 33 \text{ or}$$

$$13 + 20 = 33$$

(d) The largest product for $?? \times ??$

is $96 \times 87 = 8352$.

This is bigger than $97 \times 86 = 8342$

To get the largest product we have to multiply the largest units digit by the largest tens digit as shown by the grid method of multiplication.

×	90	6	
80	7200	480	7680
7	630	42	672
	7830	522	8352

×	90	7	
80	7200	560	7760
6	540	42	582
	7740	602	8342

We see that

$$480 + 630 = 1110$$

but

$$560 + 540 = 1100$$

Similarly $10 \times 23 = 230$ which is smaller than $13 \times 20 = 260$.

(e) The missing digit is 3 in this division:

$$816 \div ? = 272$$

$$816 \div 3 = 272$$

Diagnostic Assessment This should take about 5–10 minutes.

Write the question on the board, say to the class:

“Put up 1 finger if you think the answer is A, 2 fingers for B, 3 fingers for C and 4 fingers for D”.

1 3 4
+ ☆ 8

1 9 2

What number needs to replace the star to make the sum true?

A 5 B 4
C 6 D 1

1. Notice how the learners respond. Ask a learner who gave answer A to explain why he or she gave that answer and DO NOT say whether it is right or wrong but simply thank the learner for giving the answer.
2. It is important for learners to explain the reason for their answer to help them to develop their communication skills and also because by having to put thoughts into words we often clarify our own thinking.
3. Then do the same for answers B, C and D. Try to make sure that learners listen to these reasons and try to decide if their own answer was right or wrong.

4. Ask the class to vote again for the right answer by putting up 1, 2, 3 or 4 fingers. Notice if there is a change and who gave right and wrong answers.

5. The concept is needed for the lesson so explain the right answer or give a remedial task.

The correct answer is A because $134 + 58 = 192$.

<https://diagnosticquestions.com>

Why do this activity?

This activity develops a deeper understanding of place value and inverse operations by challenging learners to act as detectives and to solve number puzzles. They get practice in calculations in what seems to be a game. By asking for reasons for what they do to solve the puzzles, the aim is to develop the sense of number size and mathematical thinking. Learners share ideas about their intuitive methods in simple addition and subtraction problems. They handle problems with no solutions and with multiple solutions and progress to problems including multiplication and division.

Learning objectives

This activity aims to help learners to develop:

- A deeper understanding of place value.
- An understanding of inverse operations and that the word 'inverse' means 'undo'.
- A feel for the size of numbers leading to understanding of maximum and minimum values.
- Mathematical thinking and communication skills.

Generic competences

In doing this activity students will have an opportunity to:

1. **think mathematically**, reason logically and give explanations;
2. **think flexibly**, be creative and innovative - to apply knowledge and skills;
3. **research**, search for, analyse, and interpret information.

Suggestions for teaching

Resources: Copies of the worksheet on page 1 or write the questions on the board.

Start with the diagnostic quiz as a warm up.

Then introduce the question (about 5 to 10 minutes). Tell the learners that they are going to be digit detectives and they have to look for clues and solve some puzzles. Ask "What is the difference between a digit and a number?"

Tell the learners that they will start with simple calculations so they should find it easy to explain their ways of thinking about the problems.

Write $12 + ? = 19$ on the board. Explain that ? is a missing digit between 0 and 9 Ask "How will you find the missing digit?"

Share ideas as a class:

- Counting on from 12 to 19
- Just knew the answer
- Subtracting 12 from 19. *Why?*
- Because $2 + 7 = 9$

Write $?? + 150 = 257$ and $? + 8 = ?4$ on the board. Tell the learners to work with a partner to solve these puzzles and to jot down how they worked them out. Then share the strategies as a whole class. Ask "Where did you start? Why?"

Main part of lesson:

Give out the worksheet copied from page 1 or write the questions on the board.

Paired work (about 10 minutes) Ask the learners to work in pairs and solve the puzzles up to and including (a) and (b) and to make notes of the clues they used to find

the solutions. Learners who finish could make up similar problems and swop with their partner.

Class sharing (about 10 to 15 minutes) Now let's share your discoveries.

Why is it you could not find the digits in $? + 8 = 2?$

What about $2? + 4 = 1?$.

How many solutions did you find to $33 + ? = 4?$

Why is there more than one solution? How could you check you found all the solution?

Invite learners to share ideas about both $3?6 + 5? = 383$ and $8?3 - 7? = 815$.

Some learners may have used trial and improvement and others may have used their knowledge of place value. Talk about why it helps to start with the units digits then moving on to the tens.

Paired work sharing (about 15 minutes) Tell the learners to do (c), (d) and (e) and make sure that they know that each ? must represent a different digit.

Class sharing (about 10 to 15 minutes)

Ask "How can you be sure that $97 + 86$ and $96 + 87$ are the largest possible numbers?"

Ask "How can you be sure that $13 + 20$ and $10 + 23$ are the smallest possible numbers?"

"Why will it make a difference if you change over the tens and units digits?"

What about the smallest number?

"What digits did you use?"

Why can't 0 be in the tens place?"

Share solutions and strategies for $?? \times ??$ and discuss maximum and minimum values.

Ask how they solved the puzzle : $816 \div ? = 272$ and discuss inverse operations.

Key questions

- What do you notice?
- How many solutions are there to the calculations?
- What clues did you use to help you work out your answers?
- Can you explain how you solved the puzzles?
- Can you explain why this happens?
- What other combinations did you try?
- What ideas did you use?

Follow up

Find the Numbers <https://aiminghigh.aimssec.ac.za/years-6-7-find-the-numbers/>

Football Challenge <https://aiminghigh.aimssec.ac.za/years-7-12-football-challenge/>