

# Maths4Prisons

## Mathematical Magic



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## Section 1 – The Maths Mentor project

### About the Maths Mentor project

You've been trained to act as a Maths Mentor through a project established by the National Institute of Adult Continuing Education (NIACE) and funded by the Department for Business, Innovation & Skills.

The Maths Mentor project is part of a wider initiative called Maths4us, which trains maths champions inside and outside prisons to promote the benefits of learning maths and encourage others to 'get maths-active'. Maths mentors do this but also go further: you have been trained to support others to handle some everyday maths situations, tackle some maths topics, become more confident mathematically and make the most of formal and informal maths education opportunities.

### Getting started as a maths mentor

We know from our pilots that prisoners may notice your Maths4us t-shirt and ask for help with personal budgeting (for example, with the 'canteen sheet') or with reading dates and times. They may say that they'd like to get better at the times tables, adding or other topics. They may just say that they'd like to be able to help their children with maths. Or they might say they're thinking of joining a maths class but have concerns about it. So your starting point may be just an informal conversation.

### Choosing an activity

If your mentee has talked about a particular topic, look at the first page of the 'route map' in the *Maths Mentor Handbook* and then find a suitable activity. If your mentee has just said something like 'I want to get better at maths' or 'I want to be able to help my children' you could browse the route map together or look through the activities to find something that looks relevant. You don't have to work through all the activities or do them in a set order; it's better to start with something that looks interesting.

There are four learning activities booklets:

Whole Numbers

Money

Time and Distance

Mathematical Magic

### Deciding what to do next

When you and your mentee have done an activity and discussed how it went, decide together what to do next. You could use the route map in the handbook or just browse through the booklets to help with this. You don't have to work through all the activities in a booklet, or do them in any particular order, though the route map does make some suggestions. It's important to remember that the activities booklets are not textbooks that you need to work through from beginning to end. They don't cover all the maths an adult might want to know about; they're just starting points to get things moving.

In addition, you can support your mentee to think about joining a maths class; you could perhaps talk about your own experience of being in a class, or use some of the materials from your *Maths Mentor Handbook* to help your mentee think about what it would be like to be in a class, and what the benefits might be. Remember to use active listening skills during this conversation; your mentee is trying to make a decision and may want to talk things through with you in detail.

## Section 2 – Learning activities

### Multiplying by 11

**Do** Make sure you and your mentee have pen and paper handy.

**Say** *I'm going to show you a way of multiplying double digit numbers by 11, fast. If you show it to anybody else, they'll be impressed!*

*To multiply 43 by 11, put down the number 43 but leave a space in the middle, like this:*

$$4 \quad 3$$

*Then add the 4 and 3 which gives you 7, and put that in the space.*

$$4 \quad 7 \quad 3$$

*So  $43 \times 11$  is 473. You could check this on the calculator.*

**Check** Make sure your mentee understands the phrase 'double digit number'. He/she may prefer 'two figure number' instead.

To see if your mentee has understood, ask him/her to try some more multiplications, like  $27 \times 11$  or  $33 \times 11$  or  $35 \times 11$ .

Keep checking the answers on the calculator. Sooner or later you'll come across one which might be a bit puzzling.

For example, try multiplying  $57 \times 11$ .

You start as usual by putting down the 5 and the 7, leaving a space in the middle.

$$5 \quad 7$$

Then you add the 5 and the 7, which gives you 12, and if you put that in the middle, you get an answer of 5127.

But the calculator gives 627.

Can you work out what's happening here and how to put things right?

**Discuss** Any ideas why this works?

Clue: Multiplying by 11 is the same as multiplying by 10 and adding on the original number.

If you and your mentee are feeling adventurous, try to work out how to multiply three digit numbers by 11.

If you're feeling even more adventurous, try to work out a quick way of multiplying numbers by 12. Hint: multiply by 10 and add on twice the original number.

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**Reflect and record** Reflect on how this exercise went. Record the name of the exercise your mentee has just done, say how it went and invite your mentee to add comments. Discuss what you want to do at your next session; make a note of this and, if possible, arrange a time and place for the next session.

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## Multiplying by ones

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**Do** Have pens, paper and a calculator handy.  
Have a copy of the 'Multiplying by ones' sheet handy (see p. 19).

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**Say and do** *I'm going to show you an amazing pattern for multiplying, using just the number 1.*

Show your mentee the 'Multiplying by ones' sheet.

*Work out, using a calculator if you like, the answers to the first few calculations. Can you see a pattern in the answers?*

---

**Check** The answers should be 121, 12321, 1234321, etc. Depending on what kind of calculator you've got, you might be able to keep going with the bigger problems. If not, you may be able to spot the pattern by now. It helps to read out the answers 'one two one', 'one two three two one', 'one two three four three two one'. If you can see the pattern, you and your mentee can fill in the other answers.

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**Discuss** Why does this happen? Does it happen with other numbers; for example, if you started with 2 instead of 1 would you get a similar pattern?

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**Reflect and record** Reflect on how this exercise went. Record the name of the exercise your mentee has just done, say how it went and invite your mentee to add comments. Discuss what you want to do at your next session; make a note of this and, if possible, arrange a time and place for the next session.

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## All the ones

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**Do** Have a calculator handy.

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**Say** *I'm going to show you a magic way of making ones.  
Use a calculator if you like.*

*Start with the number 1.*

*Now multiply it by 3.*

*Now multiply your answer by 7.*

*Now multiply your answer by 11.*

*Now multiply your answer by 13.*

*Now multiply your answer by 37.*

*What do you see?*

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**Check** Does the calculator show 111111?

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**Discuss** Why does this happen? What would happen if you started with a different number? Try starting with other numbers between 1 and 9.

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**Reflect and record** Reflect on how this exercise went. Record the name of the exercise your mentee has just done, say how it went and invite your mentee to add comments. Discuss what you want to do at your next session; make a note of this and, if possible, arrange a time and place for the next session.

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## Your age in chocolate

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**Do** Have pen and paper handy. You might also need a calculator.

---

**Say** *I'm going to do a trick which will reveal your age.*

*How many times a day would you like to eat chocolate? It needs to be a number between 1 and 10 – it can be 1 or 10 as well. Write down your answer.*

*Multiply it by 2.*

*Add 5 to your answer.*

*Multiply your answer by 50.*

*Add the current year (e.g. 2013)*

*If today's your birthday or your birthday was earlier this year, take away 250. If your birthday is later in the year, take away 251.*

*Subtract the year of your birth.*

*The two right-hand numbers in your answer are your age.*

*The two left-hand numbers are how often you'd like to eat chocolate.*

---

**Discuss** To see why this trick works, try it out for yourself.

Can you see how the current year, the year of your birth and your age are connected in the puzzle?

And look carefully at the bit of the instructions where you're asked to add five and then multiply by 50; can you see how this connects with the bit later where you subtract either 250 or 251?

Explaining it all in detail on paper gets very long-winded, so if it still doesn't make sense, try talking it over with a colleague.

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**Reflect and record** Reflect on how this exercise went. Record the name of the exercise your mentee has just done, say how it went and invite your mentee to add comments. Discuss what you want to do at your next session; make a note of this and, if possible, arrange a time and place for the next session.

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## Multiplying by five

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**Do** Have pen and paper handy.

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**Say** *I'm going to show you how to multiply any number by 5. It works as long as you know how to divide by 2.*

*Think of any number, as big as you like, and write it down.*

*Now divide it by 2.*

*If there's nothing left over, just put a zero on the right-hand side. The number you're now looking at is the answer you'd get if you multiplied your original number by 5. Job done!*

*If there is something left over, just forget about it and put a 5 on the right-hand side; that's your answer.*

---

**Check** For example, suppose your mentee wrote down 357.

Divide that by two and throw away the remainder; you get 178. Put a 5 on the right-hand side; you get 1785, which is the answer to  $357 \times 5$ .

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**Discuss** Hint: it's to do with the fact that  $2 \times 5 = 10$ .

Hint: multiplying by 5 is the same as multiplying by 10 and dividing the answer by 2.

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**Reflect and record** Reflect on how this exercise went. Record the name of the exercise your mentee has just done, say how it went and invite your mentee to add comments. Discuss what you want to do at your next session; make a note of this and, if possible, arrange a time and place for the next session.

---

## The answer is five!

**Do** Have a pen and paper ready.

**Say** *I'm going to show you a number trick.*

*Think of a number and write it down.*

*Now write down the number that's one bigger than that.*

*Add the two numbers together.*

*Add 9.*

*Divide your answer by 2.*

*Subtract your original number.*

*What's your answer?*

**Check** Did your mentee get the answer 5?

**Discuss** Try it out for some more numbers. Does it always work? You might like to think about the algebra underlying this trick.

Here's an algebraic way of thinking about it.

### Instruction

### Algebra

Think of a number

$x$

Write down the number  
that's one bigger

$x + 1$

Add the two together

$x + x + 1$  gives you  $2x + 1$

Add 9

$2x + 1 + 9$  gives you  $2x + 10$

Divide your answer by 2

$(2x + 10) / 2$  gives you  $x + 5$

Subtract your original number

$x + 5 - x$  is just 5!

**Discuss** But if you or your mentee don't know much algebra, this is maybe not the right way to try to explain the puzzle. Have a look at this 'visualising the algebra' hint instead:

Visualise a box with the mystery number in it.

Then visualise another box with the same number, and then add an extra 1.

You've now got two identical mystery boxes, plus an extra 1.

Add 9, so you now you've got two mystery boxes and an extra 10.

Vanish half of your image, so you've now got one mystery box plus 5.

Subtract your original mystery number; i.e. vanish the mystery box.

You've got 5 left!

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**Reflect and record** Reflect on how this exercise went. Record the name of the exercise your mentee has just done, say how it went and invite your mentee to add comments. Discuss what you want to do at your next session; make a note of this and, if possible, arrange a time and place for the next session.

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## The answer is still five!

**Do** Have a pen and paper ready. You might also need a calculator.

**Say** *I'm going to show you another trick with the number five.*

*Write down any number between 1 and 99.*

*Multiply this number by 5.*

*Add 25 to your answer.*

*Divide by 5.*

*Subtract your original number.*

*What's your answer?*

**Check** Did your mentee get an answer of 5?

**Discuss** Try it out with other numbers. Does it always work? Here's the algebraic version.

Instruction	Algebra
Write down any number between 1 and 99	$x$
Multiply by 5	$5x$
Add 25 to your answer	$5x + 25$
Divide by 5	$(5x + 25) / 5$ gives you $x + 5$
Subtract your original number	$x + 5 - x$ gives you 5!

**Reflect and record** Reflect on how this exercise went. Record the name of the exercise your mentee has just done, say how it went and invite your mentee to add comments. Discuss what you want to do at your next session; make a note of this and, if possible, arrange a time and place for the next session.

## Number tricks

Note to mentor: when you're doing these tricks, make sure your mentee does each stage in turn, but doesn't tell you the answers.

So in Trick 1, if your mentee thinks of the number 7 to start with, they should then get 14, 20, 10 and 3 as the answers at each stage.

Some people may think you want them to apply each stage to the number they thought of, getting 14, 13, 3.5 and  $-3.5$  as their answers; that won't work!

If you're interested in algebra, you might like to try to discover why these tricks work. The activities called 'The answer is five' and 'The answer is still five' show how to use algebra for those tricks; reading them may help you get started here.

### Trick 1

**Say** *Think of a number, but don't tell me what it is.  
Double it.  
Add 6.  
Divide by 2.  
Take away the number you first thought of.*

**Say** *I can tell you your final answer: it's 3.*

### Trick 2

**Say** *Think of a number, but don't tell me what it is.  
Subtract 1.  
Multiply by 3.  
Add 12.  
Divide by 3.  
Add 5.  
Take away the number you first thought of.*

**Say** *I can tell you your final answer: it's 8.*



**Trick 3**

**Say** *Think of a number, but don't tell me what it is.  
Multiply by 3.  
Add 45.  
Multiply by 2.  
Divide by 6.  
Take away the number you first thought of.*

---

**Say** *I can tell you your final answer: it's 15.*

---

**Trick 4**

**Say** *Think of a three digit number where all the digits are the same, e.g. 999 or 111, but don't tell me what it is.  
Add up the digits.  
Divide your answer into the original three digit number.*

---

**Say** *I can tell you your final answer: it's 37.*

---

**Trick 5**

**Say** *Think of two single digit numbers, but don't tell me what they are.  
Choose one of them and double it.  
Add 5.  
Multiply by 5.  
Add the second number you thought of.  
Subtract 25.*

---

**Say** *I can tell you that your final answer has two digits and they are the two numbers you first thought of.*

---

### Trick 6

**Do** Have pen and paper handy.

#### Example

<b>Say</b>	<i>Think of three numbers, but don't tell me what they are.</i>	Your mentee might choose 2, 9 and 7.
	<i>Arrange these numbers so as to make the biggest number possible.</i>	972
	<i>Now arrange the three numbers to make the smallest possible number possible.</i>	279
	<i>Subtract this smallest answer from the largest one you made earlier.</i>	Your mentee should subtract 279 from 972, getting an answer of 693.
	<i>Reverse this result.</i>	Reversing would give 396.
	<i>Add this to your previous answer</i>	Your mentee would now add 693 and 396

**Say** *I can tell you what your final answer is: it's 1089.*

**Reflect and record** Reflect on how this exercise went. Record the name of the exercise your mentee has just done, say how it went and invite your mentee to add comments. Discuss what you want to do at your next session; make a note of this and, if possible, arrange a time and place for the next session.

## Trick questions

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**Do** Do not take this section too seriously! But be careful if you're using these; some people might not find them funny. People whose English isn't strong may not understand the solutions immediately.

---

**Say** *Here's a mathematical trick question, just for fun.*

*I have two coins which add up to 60 pence. One of them isn't a 50 pence piece. What are the coins?*

---

**Solution** *One coin wasn't a 50 pence piece, but the other one was – the two coins are 50p and 10p.*

---

**Say** *Here's a mathematical trick question, just for fun.*

*A hammer and a nail cost £31. The hammer cost £30 more than the nail. How much did they each cost?*

---

**Solution** *The hammer costs £30.50 and the nail costs £0.50.*

---

**Say** *Here's a mathematical trick question, just for fun.*

*A man wanted to plant four trees, but all four had to be equal distances from each other. How did he do it?*

---

**Solution** *He planted three at the corners of an equilateral triangle. Then he made a mound in the middle, high enough so that its top was as far away from each tree as the sides of the triangle, and he put the last tree on the top of this tetrahedron.*

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**Reflect and record** Reflect on how this exercise went. Record the name of the exercise your mentee has just done, say how it went and invite your mentee to add comments. Discuss what you want to do at your next session; make a note of this and, if possible, arrange a time and place for the next session.

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## Magic squares

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**Do** Have 'Magic Square 15' ready (see Appendix), some 'What's the magic number?' puzzles, and Card Set A (but leave out the zero and the ten – again, see Appendix).

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**Say and do** *I'm going to show you a 'magic square'. These have been mathematical curiosities for hundreds, perhaps thousands, of years. They are also a good way to practise adding whole numbers.*

*Look at Magic Square 15. It contains the numbers 1, 2, 3, 4, 5, 6, 7, 8, 9. If you add up each row and then add up each column, you'll see something interesting. Try the diagonals as well.*

---

**Check** Has your mentee got 15 as the answer for each row and each column? What about the diagonals?

---

**Discuss** Would it still work if you used the same numbers but put them in different boxes? Try it out with the cards from number card set A (leaving out the zero and the ten).

Or try completing some of the unfinished magic squares in the Appendix. All of them use the numbers **1, 2, 3, 4, 5, 6, 7, 8, 9**. You could write numbers in the boxes or use the number cards.

Note: is the magic number always 15?

There's also a totally blank square so that you can try to create a new magic square. Enjoy.

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**Reflect and record** Reflect on how this exercise went. Record the name of the exercise your mentee has just done, say how it went and invite your mentee to add comments. Discuss what you want to do at your next session; make a note of this and, if possible, arrange a time and place for the next session.

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## Appendix

### Multiplying by ones

$$1 \times 1 = 1$$

$$11 \times 11 =$$

$$111 \times 111 =$$

$$1111 \times 1111 =$$

$$11111 \times 11111 =$$

$$111111 \times 111111 =$$

$$1111111 \times 1111111 =$$

$$11111111 \times 11111111 =$$

$$111111111 \times 111111111 =$$

Card Set A

0	1	2
3	4	5
6	7	8
9	10	

## Magic square 15

8	1	6
3	5	7
4	9	2

### Magic square 15: Puzzle 1

8		
1	5	
	7	



## Magic square 15: Puzzle 2

	9	2
8		

### Magic square 15: Puzzle 3

6		
	5	
8		

## Magic square 15: Puzzle 4

4		
	5	7
	1	

Magic square 15: Puzzle 5

	7	
9		
4		

## Magic square 15: Puzzle 6

		8
	5	
	7	

### Magic square 15: Puzzle 7














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