Enrichment **Activities**

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How does maths apply to a card trick? Can you really use maths in fun and exciting ways? In fact, card trickery is just one area out of a huge number of entertaining and innovative ways that maths can be used.

This booklet has been designed to highlight the ways that maths is used in daily life. The puzzles guide you through from the question to the discussion of how much fun maths can be and to highlight the many ways in which it can be applied to an everyday setting.

This booklet has been produced by *more maths grads*. *more maths grads* (MMG) is a three-year project funded by the Higher Education Funding Council for England to develop, trial and evaluate means of increasing the number of students studying mathematics and encouraging participation from groups of learners who have not traditionally been well represented in higher education.

MMG has also been working with the Higher Education Funding Council for Wales to translate and disseminate its resources throughout Wales.

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Fractals **Problem**

Equipment required:

- Lots of A4 paper (about 5 sheets per student)
- Scissors
- Pictures of fractals

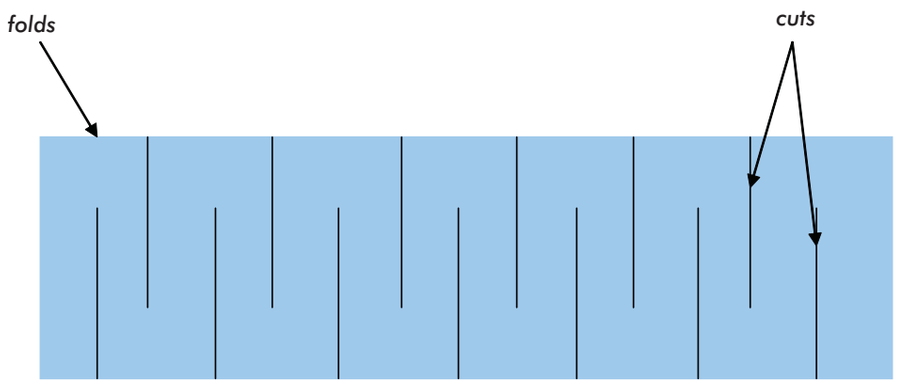
Instructions:

- Give students a pair of scissors and a piece of paper.
- Ask them to make a hole in the paper so that they can put their hand through it. The remaining paper must form a complete loop.
- Give students a new piece of paper.
- Ask the students to make a hole so that they can put their head through.

Again the remaining paper must form a complete loop.

- Give students a third piece of paper.
- Ask the students to make a hole so that they can put their whole body through. Again the remaining paper must form a complete loop.
- If students succeed challenge them to get themselves and as many friends as possible through the paper.

(SOLUTION: The solution is to fold the paper in half and make cuts on alternate sides as shown in the diagram)



Discussion:

Following discussion could include:

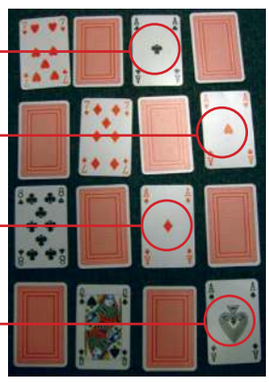
- Changing the perimeter of a shape without changing the area.
- Fractals and some images of fractals.
- Similar ideas in nature, for example the surface area of the lungs and intestine.

All the **Aces**

Arrange 16 playing cards in a chessboard formation. Choose a "line", either horizontal or vertical. Then "fold" along that line, as though you were folding a piece of paper.

Keep choosing lines to fold along, until you have folded up the whole pack. You should find that whatever way you have folded up the pack, all the cards end up facing the same way. This trick relies on the principle that whenever you fold up a chessboard of cards (try different sizes), they will always end up facing the same way.

Now replace four of the upturned cards with Aces:



Now turn these aces over.

The idea is to prearrange the pack. Here this has been done with the Aces in the 3rd, 8th, 11th, and 16th positions. Then if you deal out the pack left to right, top to bottom, you can "randomly" turn over cards 1,6,9 and 14. When you fold up the pack, the Aces will be facing the "wrong" way.

You have "magically" turned the four up-turned cards into Aces.

Get the pupils to think about why folding up a chess board will always end up with all the cards facing the same way.

The idea for this trick was given to us by Rob Eastaway. (www.robeastaway.com)

Johnny Ball's favourite **Card Trick**

1. Make sure you have a complete set of 52 cards without the jokers.

2. Deal out 9 cards. Get a pupil to select a card from these 9 and show it to the class, but make sure you don't see it.

3. Put their selected card on the top of the other eight cards. Put the nine cards on the bottom of the pack. As you can see, the special card is now in the 44th position.

4. Now start dealing out the pack, counting down from 10. You are waiting for the cards to "speak" to you. With younger pupils it is probably a good idea to make a bit of a show of this.

5. The cards "speak" if you deal out the number you have just spoken. For example if I have counted down to seven and deal the number seven at the same time, then the cards have "spoken" and you stop there.

6. Then start a new pile, again counting down from 10. If you get down to one and find that the cards haven't spoken, then cap the pile with the next card placed face down. (Meaning you have 11 cards in the pile.)

7. Continue doing this until you get four piles. You will most probably have some number cards facing upwards.

Ask the class what you could do with these numbers. (Hopefully after some directed prompting the class will suggest you add these numbers and maybe even that you deal out that number of cards from the remainder of the pack.) In the example, the upturned numbers add up to 17. Now deal out 17 cards and turn over the 17th card. Miraculously, this will be the card chosen at the beginning.

8. **On the very rare occasion that the cards don't speak, turn over the card that you are capping the fourth pile with. This will be the special card**

Explanation: Get the pupils to notice where you put the special card. (It is always in the 44th position.) This trick is all about a special way of counting to 44.

Imagine if no cards spoke. Then you would find that you would have four piles of eleven cards and the 44th card would cap the final pile.

However if the cards do speak, then notice what happens. If the card speaks on seven, then you have counted out four cards and are seven cards short of eleven. If the cards speak on 5, then you have counted out six cards and are five cards short of eleven. The upturned cards are telling you how many cards you need to make piles of eleven. So overall, if you add up the numbers on the upturned cards, it will tell you how many cards you need to count out in order to make 44 cards.

Mystic **Richard**

You need to have two people who have learnt the trick. The thinking behind it is quite complex, so we have only done this with the older age groups.

1. Audience member shuffles the pack and deals out 5 cards to person B.

2. Person B says confidently that he can "psychically" transmit the identity of one of the cards to "Mystic Richard" (Person A).

How Person B must arrange the cards.

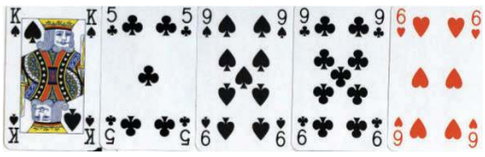
- Any five cards must have a suit featured more than once
- Place the cards of repeating suit in Positions 2 and 5
- Mystic Richard will have to guess card 5. By looking at card 2, he will immediately know the suit of card 5.
- Now cards 1,3 and 4 will tell Person A how many places he needs to count on from card 2, in order to get to card 5's place value. (For example if card is the 3 of hearts and card 5 is the 6 of hearts, he must count on 3 places.)
- Card 2 and card 5 can be arranged so that you only ever need to add on a maximum of 6 to card 2 in order to get card 5. (Assuming the pack is cyclic, if you add 3 to the King of Hearts, this will give you the 3 of Hearts)
- Now place cards 1,3 and 4 in order, according to the table below. Assume Ace is low.

Order of Cards 1,2 and 3	How many you should count on from Card 2, to get to Card 5
Low Medium High	1
Low High Medium	2
Medium Low High	3
Medium High Low	4
High Low Medium	5
High Medium Low	6

- If cards 1,3 and 4 contain a repeating value (e.g. 2 Kings) then we need to use Bridge Order. Clubs < Diamonds < Hearts < Spades.

3. Now Mystic Richard simply needs to look at the first four cards and he will be able to work out the identity of the fifth card (supposing person B has arranged them correctly!)

Example
Suppose you select the cards below.



The Spades are repeated, as well as the Clubs, so you have a choice. I would put the 5 of Clubs in the 2nd Position and the 9 of Clubs in the 5th Position. This means I need to add 4 to the 5 of clubs in order to get the 9 of Clubs. I therefore need to put the other three cards in the position: medium high low. (Nine, King, Six)

Mystic Richard is now ready to work out what the fifth card is.

Discussion with the class:
Some pupils will probably not believe you that this can be done for any combination of cards.

The idea for this trick was given to us by Rob Eastaway.(www.robeastaway.com)

Three Jugs **Problem**

Two friends who have an eight-quart jug of water wish to share it evenly. They also have two empty jars, one holding five quarts, the other three. How can they each measure exactly 4 quarts of water?

Investigate!!

3 quarts 5 quarts 8 quarts

Number **Puzzles**

Try these tricks on your friends and family

Birthday Trick

Get your friend to do the following steps

1. Write down the month of their birth as a number. E.g. February is 2
2. Double this number
3. Add 5
4. Multiply by 50
5. Add their age
6. Subtract 365

At this point get your friend to call out the total.

In your head secretly add 115. You will now have a three digit number. The first number will be the month of their birth. The second two numbers will be their age. So for example: 240 would mean that they were born in February and that they are 40 years old.

A Number Trick which doesn't go out of date

Get your friend to do the following steps:

1. Write down the year in which they were born
2. Write down an important year in their lifetime
3. Write down the number of years which have elapsed since that important year
4. Put down their age this year on their birthday
5. Add up the numbers on their list
6. Divide by 2

They should be left with the current calendar year.

Maths at Work **Mpegs**

Exciting video resources are available on the Maths Careers website. The Mpegs aim to contextualise the link between maths and industry. These are also available with welsh subtitles.

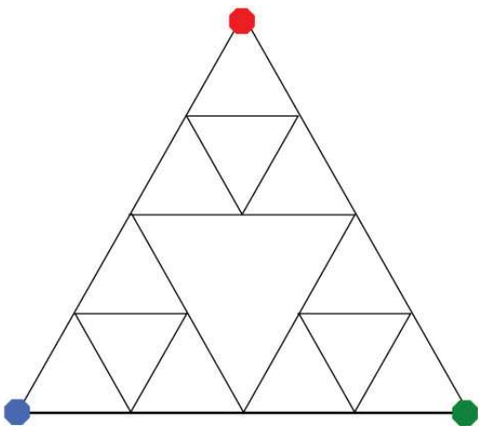
Please visit www.mathscareers.org.uk

Sierpinski **Game**

Play in pairs. Decide who will go first. You'll need a ruler and a pen or pencil. Player 1 chooses a corner to start at: red, green or blue. Player 2 chooses one of the nine small triangles pointing upwards as the target.

A move consists of moving your counter exactly halfway to one of the corners. So the move "red" means move halfway from where you are to the red corner. Player 1 has to find a combination of moves which move from the starting corner into the target triangle. The player has to get INSIDE the triangle, not on any of its edges. Count the number of moves it takes – that's Player 1's score. Now swap over. Keep a total of the scores and see who can get the lowest score over several rounds.

Extension: divide each triangle up into smaller triangles. If you choose a triangle pointing upwards, how many moves does the other player need to get inside it?

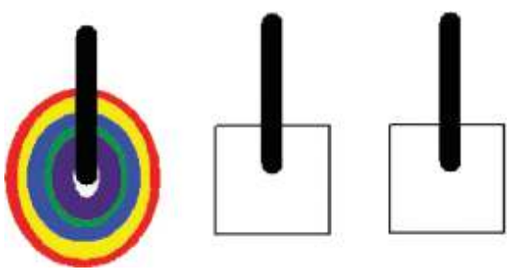


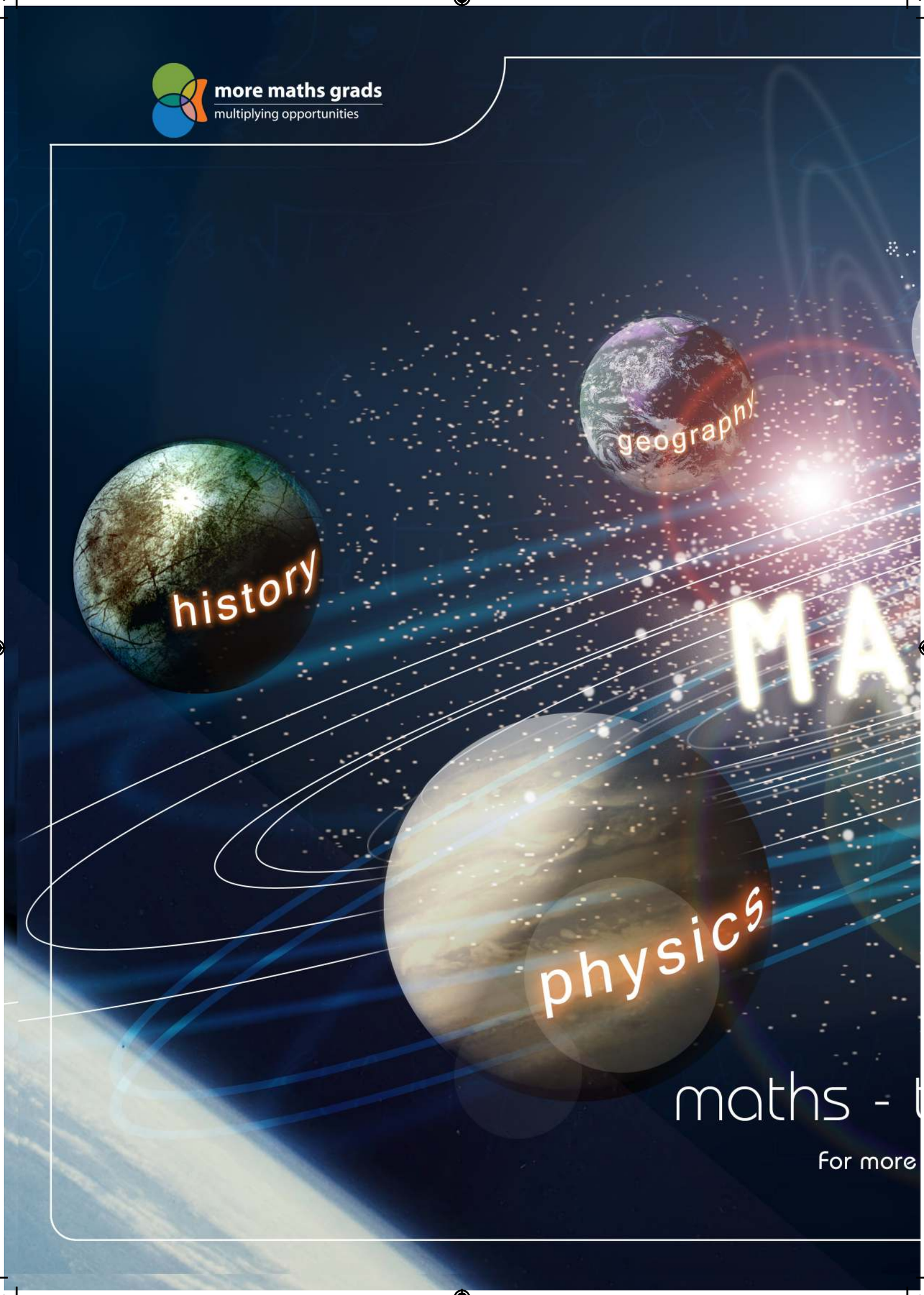
The Towers of **Hanoi**

Move the rings to the third tower so that they are arranged from biggest to smallest.

Rules:

1. You can only move one ring at a time to a neighbouring tower.
2. You cannot place a bigger ring on top of a smaller ring.
3. Try to do this in the least amount of moves possible.

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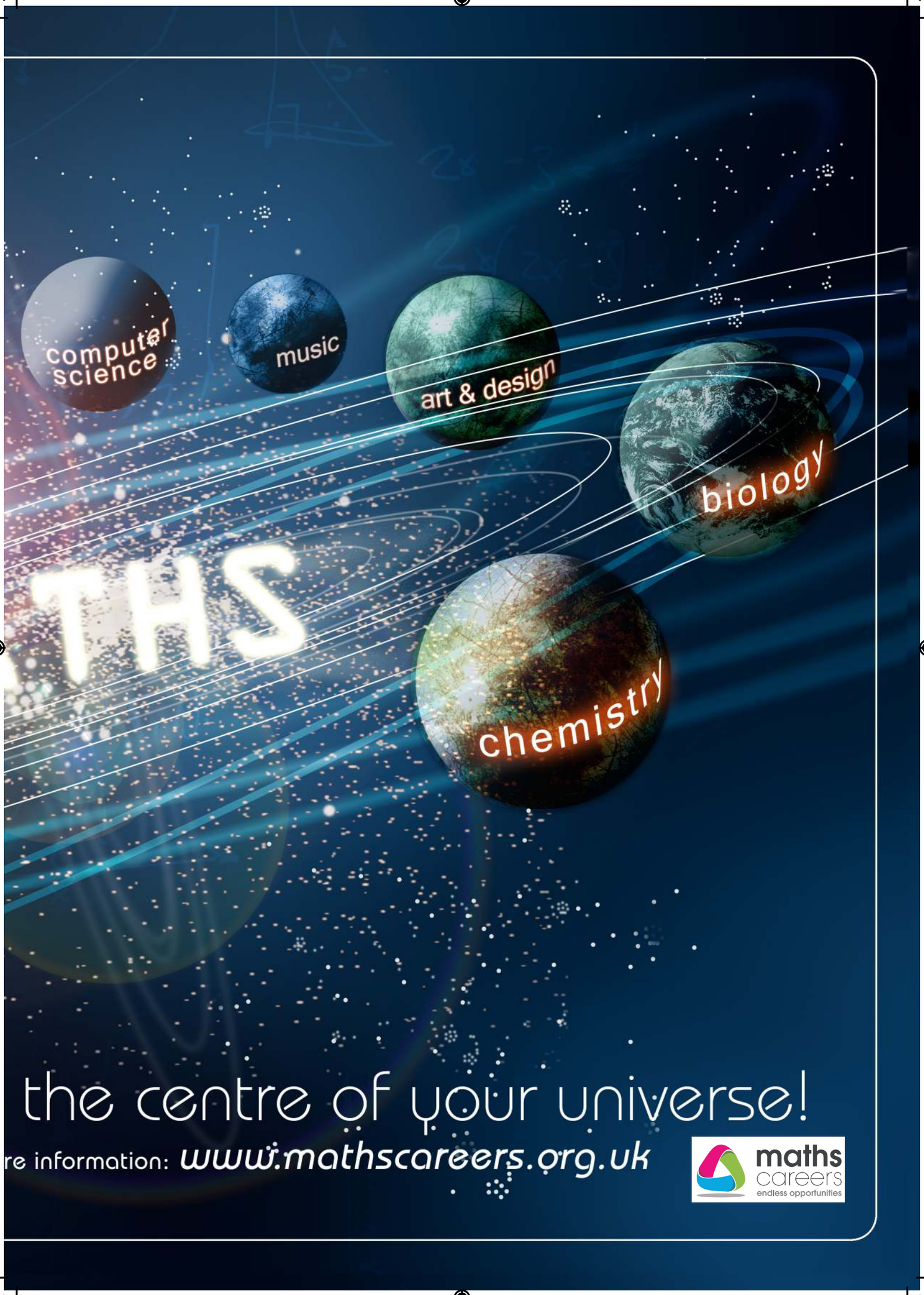
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