TEACHER NOTES BIRTHDAY MAGIC TRICK

Here is a trick you could use to introduce your students to binary.

Show your students the image of the cards on 'Birthday Magic Trick' sheet, or print them a copy of the cards ('Birthday Magic Cards – Print Out').

Ask them to see which of the cards their birthday is on. It might be on all, some or only one of the cards.

Ask a student which cards their birthday is on and then just by 'reading their mind' you can tell them what their birthday is! They'll be amazed. But what you're doing is using some maths to make this trick work.

Birthday Numbers in Binary

The numbers have been arranged on the cards based on what that number is when written in binary.

Binary is a number base (base 2) that only uses 0s and 1s, and has powers of two (in green below), rather than powers of ten (units, tens and hundreds) as its place value headings.

Therefore, the number 11001 if read in binary means: 16 + 8 + 1 = 25

16	8	4	2	1
1	1	0	0	1

So, when writing a number in binary we're essentially indicating which powers of two sum to make that number. Each birthday number from 1 to 31 can be written in binary using five columns.

Now notice there are five cards and that on the cards successive powers of two are featured as the top left number on the cards.

If we raise the card number to the power of 2, we get the number circled in the top left corner of that card. Eg $2^0 = 1$, $2^1 = 2$ and so on.

You might notice all the numbers on Card 0 are odd. This means all numbers on Card 0 have a 1 in their 1s (2^0) column when written in binary. And all the numbers on Card 1 have a 1 in the 2s (2^1) column when written in binary. And all the numbers on Card 2 have a 1 in the 4s (2^2) column when written in binary. And so on…

So, when someone tells you their birthday is on card 4 and card 2, they are effectively saying their birthday in binary is: 10100, and is found with the sum $2^4 + 2^2$

In short, add the circled numbers in the top left of each of the cards they say and you will get their birthday!

In the classroom

After you've done a few demonstrations, you could ask students to **look for patterns** in the numbers on the cards. They might spot that all numbers on Card 4 are 16 or greater, or that all numbers on Card 0 are odd. These patterns can be explained by binary.

They might **notice the powers of two** in the top left corners. They could circle them on write them out above the cards.

To help students see the **connection between the powers of two and the birthday numbers**, you could do these examples like these:
-the birthday number 4 (notice it is only on the card with the 4 in top left corner)
-the birthday number 5 (notice it is on the card with the 4 in the top left corner, and the one with the 1 in the top left corner).

After a few more examples they might notice that they are summing the circled numbers for the cards that have been chosen.

Could you challenge the students to **do the trick in reverse**? Can they work out which cards certain numbers would be on without looking at the cards?

When doing this they will be working out which powers of two sum to make particular numbers, and that means they are effectively **writing numbers in binary**!

This could be a nice launch off point to introduce them to binary.