**Mind reading with mathematics**

**Is it magic or is it mathemagic?**

**Birthday Card Trick**

#### **Impress your friends and family with this math trick!**

1. Get a set of 5 “Magic Birthday Cards” like the ones given to you after the presentation. Each card should have 16 numbers on it.
2. Ask a friend to pick a secret number between 1 and 31 (or ask for their birthday date).
3. Show them each card one by one. For each card, ask “Is your number on this card?” For each card that they say “yes,” look at the number in the top left corner (or have it written on the back of the card).
4. You can figure out their secret number by adding together all of the numbers in the top left corner of their “yes” cards.

#### **Why does it work?**

The key is the **binary number system**. Every number can be written as a binary number, which means it can be written as a sum of powers of 2.

Examples: **19** = 16 + 2 + 1; **28** = 16 + 8 + 4; **43** = 32 + 8 + 2 + 1; and so on…

The digits in binary are 0’s and 1’s, so our examples look like **10011**, **11100**, **101011**.

A digit of 1 is like saying “yes” to a card. You may recognize binary if you are familiar with computers or other machines that understand this yes/no language.

Using one of our examples, 19 = 16 + 2 + 1 = 24 + 21 + 20, so in binary we write 10011.

Now notice that the number 19 appears only on three of our magic cards. That is, 19 appears on the cards with first numbers 16, 2, and 1, and it does not appear on the cards with 8 or 4.

The five cards correspond to the powers of 2. The numbers that are on the first card (with "16" as the first number) are the ones that have a "1" in the 16's position when we write it in binary. The numbers on the "8" card are those with a "1" in the 8 position in binary. And so on for the other cards.

So, when you add up the first numbers on the cards that the "secret" number is on, you are adding up the powers of 2 that sum to the secret number!

*More MatheMagic…*

**The Missing Digit**

* Ask a friend to secretly write down ANY number (at least four digits long). e.g. 78341
* Ask the friend to add up the digits... e.g. 7+8+3+4+1 = 23
* ... and then subtract the answer from the first number. e.g. 78341 - 23 = 78318
* Your friend then crosses out ONE digit from the answer. (It can be any digit except a zero) e.g. 7x318 (You have no idea what your friend has written!)
* Your friend then reads out what digits are left in ANY order. e.g. 1-8-3-7
* Even though you haven't seen any numbers, you can say what the missing digit is! EIGHT

**THE SECRET**

**This trick relies on the divisibility rule for the number 9.**

* After your friend has added up the digits and subtracted them, the answer will ALWAYS be divisible by 9. If a number is divisible by 9, then when you add the digits up, they will also be divisible by 9. If you check our example 7+8+3+1+8 = 27 which is divisible by 9.
* When your friend crosses a digit out, she then reads out the digits that are left. You add them up. In the example we had 1+8+3+7 = 19
* All you do now is see what you have to add on to your answer to get the next multiple of 9! (A multiple of 9 is a number that is divisible by 9.) The next multiple of 9 after 19 is 27. So you need to add on EIGHT. This is the number that was crossed out!

\*\*Explanation borrowed from <http://www.murderousmaths.co.uk>

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**Resources**

**NCTM Illuminations –** an online library of interactive games and math activities for ages K-12. Designed to be used at home or in the classroom. [www.illuminations.nctm.org](http://www.illuminations.nctm.org)

**Numberphile** – a series of fun numbery videos, supported by the Mathematical Sciences Research Institute. Check them out on facebook and twitter! [www.numberphile.com](http://www.numberphile.com)

**Which One Doesn’t Belong? –** a website dedicated to providing thought-provoking puzzles for math teachers and students alike. [www.wodb.ca](http://www.wodb.ca)

**Youcubed –** an online resource to inspire all students with open, creative mindset mathematics. Check out creator Jo Boaler’s book, “Mathematical Mindsets”. [www.youcubed.org](http://www.youcubed.org)