ALU SCHOOL OF MATHEMATICS

ALU MATHS NEWS

Volume 1, Issue 6 **News Letter** *Since: 05/10/2016*

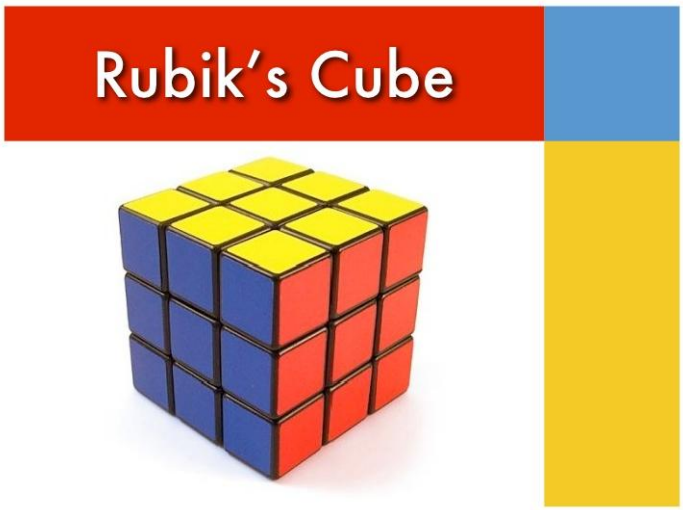
We are delighted to bring to you this issue of ALU Mathematics News, a monthly newsletter dedicated to the emerging field of Mathematics. This is the first visible —output from the Department of Mathematics, Alagappa University. We are committed to make ALU Mathematics News a continuing and effective vehicle to promote communication, education and networking, as well as stimulate sharing of research, innovations and technological developments in the field. However, we would appreciate your feedback regarding how we could improve this publication and enhance its value to the community. We are keen that this publication eventually grows beyond being a mere —news letter to become an invaluable information resource for the entire Mathematics community, and look forward to your inputs to assist us in this endeavor.

Dr. N. Anbazhagan

Rubik's Cube on Mathematics

"We turn the Cube and it twists us" -- *Erno Rubik*

The Rubiks Cube is a cube consisting of 6 sides with 9 individual pieces on each. The main objective when using one is to recreate it's original position, a solid color for each



side, with out removing any piece from the cube. Though it is colorful and looks like a children's toy, there have been many championships for it's completion. It amused five year-olds yet inspired mathematicians.

It's unique design was made by an engineer named Erno Rubik, a socialist bureaucrat who lived in Budapest, Hungary. He built the simple toy in his mother's apartment and did not know of the 500 million people who were going to become overly perplexed over it. His first idea of the cube came in the Spring of 1974.

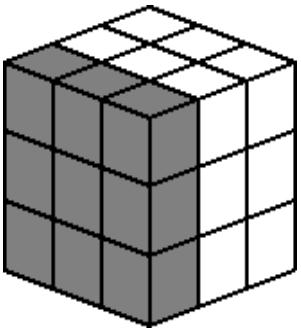
What inspired Erno was the popular puzzle before his called the 15 Puzzle. Invented in the late 1870's, this puzzle consisted of 15 consecutively numbered, flat squares that can be slid around inside a square frame. Sam Loyd created this two dimensional version of the Rubiks Cube. The puzzle was originally called the Magic Cube, or Buvuos Kocka in Hungarian. It was later renamed in honor of it's creator to the Rubiks Cube. Many different cube variations have been made, but the one discussed here is called the standard 3x3x3. It contains 26 little blocks of plastic.

The Rubiks Cube has been a successful product for many years. Though created without great intentions, people have spent millions of dollars on it. Math classes to this day study the complexity of the Cube. Erno, the creator of the cube, became an overly rich man from his ingenious creation.

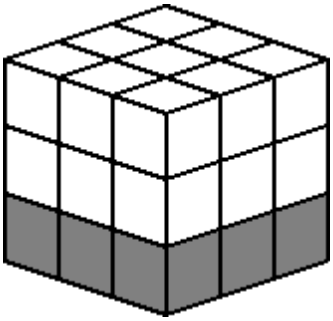
Notations

Throughout this discussion, we will use the following notation to refer to the sides of the cube:

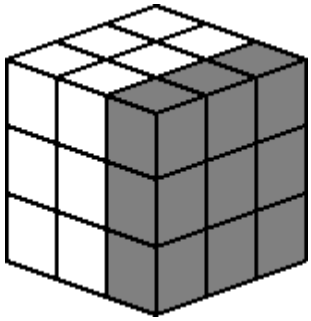
Front F



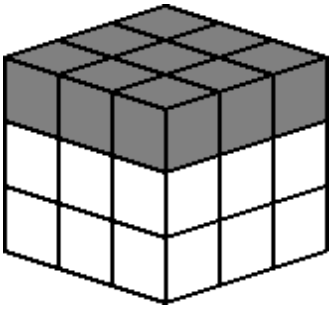
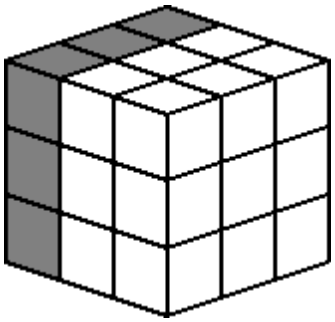
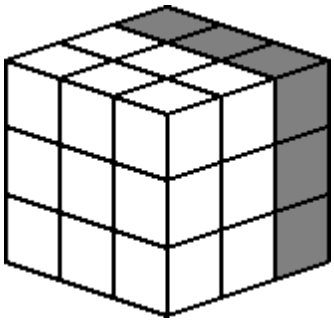
Down D



Right R



Up U Left L Back B

Bounds on Solving a Rubik's Cube

The number of possible permutations of the squares on a Rubik's cube seems daunting. There are 8 corner pieces that can be arranged in 8! ways, each of which can be arranged in 3 orientations, giving 3^8 possibilities for each permutation of the corner pieces. There are 12 edge pieces which can be arranged in 12! ways. Each edge piece has 2 possible orientations, so each permutation of edge pieces has 2^{12} arrangements. But in the Rubik's cube, only $\frac{1}{3}$ of the permutations have the rotations of the corner cubies correct. Only $\frac{1}{2}$ of the permutations have the same edge-flipping orientation as the original cube, and only $\frac{1}{2}$ of these have the correct cubie-rearrangement parity, which will be discussed later. This gives:

$$\frac{(8! \cdot 3^8 \cdot 12! \cdot 2^{12})}{(3.2.2)} = 4.3252 \cdot 10^{19}$$

possible arrangements of the Rubik's cube.

Groups

Definition

By definition, a group G consists of a set of objects and a binary operator ' * ' on those objects satisfying the following four conditions:

- The operation * is closed, so for any group elements h and g in G, h*g is also in G.
- The operation * is associative, so for any elements f, g, and h,

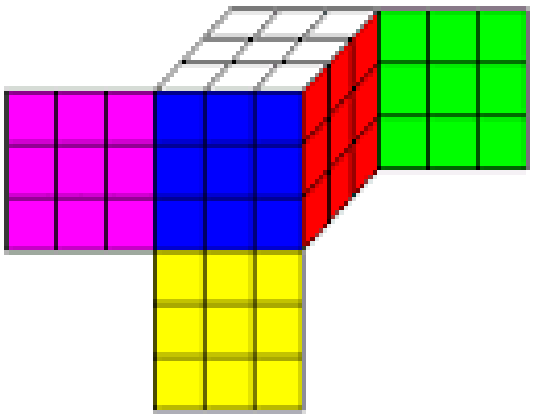
$$(f * g) * h = f *(g * h).$$

- There is an identity element $e \in G$ such that $e * g = g * e = g$.
- Every element in G has an inverse g^{-1} relative to the operation * such that

$$g * g^{-1} = g^{-1} * g = e.$$

The Rubik's cube group (RC-G)

We can make the set of moves of the Rubik's cube into a group,



which we will denote (RC-G, *). - The group operation * will be defined like this: if M1 and M2 are two moves, then M1* M2 is the move where you first do M1 and then do M2. - it can be easily shown that * is closed and associative - all moves has an inverse - and unit element is the "empty" move RC-G defined this way is a group.

World Records

Blindfold, fastest time (including memorising): 32.27 sec, Haiyan Zhuang (China) at the Shanghai Winter Cubing Festival on 7 February 2010 (

- **Blindfold, fastest time (time does not include memorising):** 23.06 seconds, Clément Gallet (France) at the European Rubik's Cube Championship 2006 in Paris
- **Blindfold, most cubes:** 24, Tim Habermaas (Germany) at the German Open 2008 in Gütersloh
- **One handed:** 11.97 sec, Chris Dzoan (USA) at the Bayview Hills Open 2010 on 16 January 2010
- **With feet only:** 36.72 sec, Anssi Vanhala (Finland) at the Estonian Open 2009 on 7 November 2009 in Kose, Estonia
- **24 hours:** 4786 cubes solved, Milán Baticz (Hungary) on 16/17 November 2008

- **4x4x4 CUBE**

fastest time: 36.46 sec, Dan Cohen (USA) at the World Championships 2009 in Düsseldorf
blindfold, fastest time (including memorising): 4:42.34 min, Ville Seppänen (Finland) at the Aachen Open 2010

5x5x5 CUBE: Fastest time: 1:07.25, Dan Cohen (USA) at the Big Cubes Summer competition 2009 on 26 July in Allentown, Pennsylvania, (USA)
blindfold, fastest time (including memorising): 15:22,00 min, Chris Hardwick (USA) at the Washington DC Open on 17 May 2008

6x6x6 CUBE: fastest time: 2:15.53 min, Michal Halczuk (Poland), Silesia Open 2009, 28 November 2009

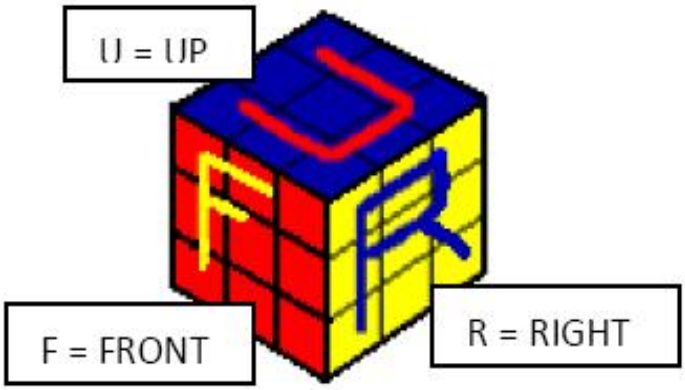
7x7x7 CUBE: fastest time: 3:43.15 min, Michal Halczuk (Poland) at the World Championships 2009 in Düsseldorf

Jean Pons (France)	Dutch Open 2005	11.75
Leyan Lo (USA)	Caltech Winter competition 2006	11.13
Toby Mao (USA)	US Championship 2006	10.48
Edouard Chambon (France)	Belgian Open 2007	10.36
Thibaut Jacquinot (France)	Spanish Open 2007	9.86
Erik Akkersdijk (Netherlands)	Dutch Open 2007	9.77
Ron van Bruchem (Netherlands)	Dutch Championships 2007	9.55
Edouard Chambon (France)	Murcia Open 2008	9.18
Yu Nakajima (Japan)	Kashiwa Open 2008	8.72
Erik Akkersdijk (Netherlands)	Czech Open 2008	7.08 VIDEO

Solving the Rubik's Cube with Eight Algorithms

This is a step by step guide on solving the classic Rubik's Cube, invented by Enrno Rubik. Although it may look almost impossible to solve, with its many faces and multiple combinations possible, it can be done. Before attempting to solve it, it is best to familiarize oneself with the arrangement, colors, and the different turning combinations. From then, understanding the eight algorithms or the combinations of turns, and their purposes are extremely important in getting to the final solution. The following guide, if followed properly,

will help you accomplish the puzzle. The step by step procedures will be accompanied by diagrams to help you stay on track. Finally, remember that solving the Rubik's Cube takes practice as well as persistence. The final result will be worth the time. It may be necessary to start by practicing the eight algorithms several times to get used to the patterns. Good luck and enjoy!



Terminology

The algorithms are dependent on rotating the different cube faces. So in order to understand what the algorithms mean, it is important to know how to turn the cube. Please take a few minutes rotating the cube for each motion, as well as understanding the different abbreviations mean. For the following table, CCW stands for counterclockwise.

Algorithms

The algorithms are step combinations that move a certain block to a preferred spot. It is important that the algorithms are performed with the correct front face.

LIST OF ALGORITHMS
1) Fi U Li Ui
2) Ri Di R D
3) U R Ui Ri Ui Fi U F
4) Ui Li U L U F Ui Fi
5) F R U Ri Ui Fi
6) R U Ri U R U U Ri
7) U R Ui Li U Ri Ui L
8) Ri Di R D

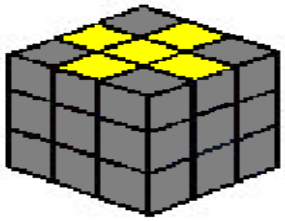
For details on how to hold the cube during an algorithm, look at each individual section under *Solving the Cube*. Here is a list of the eight algorithms for reference.

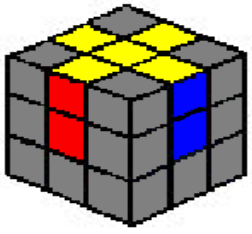
a)	F:	Front Clockwise		Fi:	Front Inverse (CCW)	
b)	U:	Up Clockwise		Ui:	Up Inverse (CCW)	
c)	R:	Right Clockwise		Ri:	Right Inverse (CCW)	
d)	L:	Left Clockwise		Li:	Left Inverse (CCW)	

Solving the Cube

The Plus Sign

To start solving the cube, make a plus sign on any surface. There is no specific algorithm dedicated to this first step, just close observations of how colors are patterned. I have chosen the color yellow.

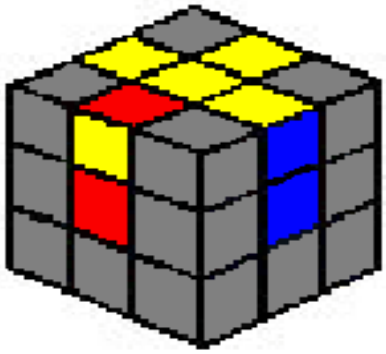




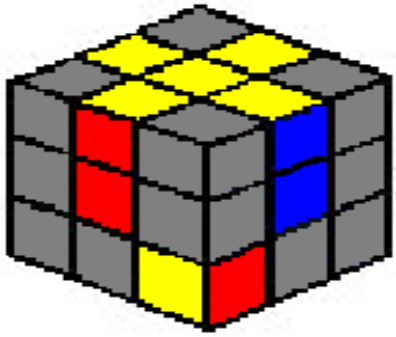
Now you must align the middle center pieces to match with the middle edge pieces like the two reds and two blues in the diagram. Try not to move the parts of the plus sign that you have already solved.

If the following Yellow-Red position occurs, then perform algorithm 1 to fix the alignment.

(1) Fi U Li Ui



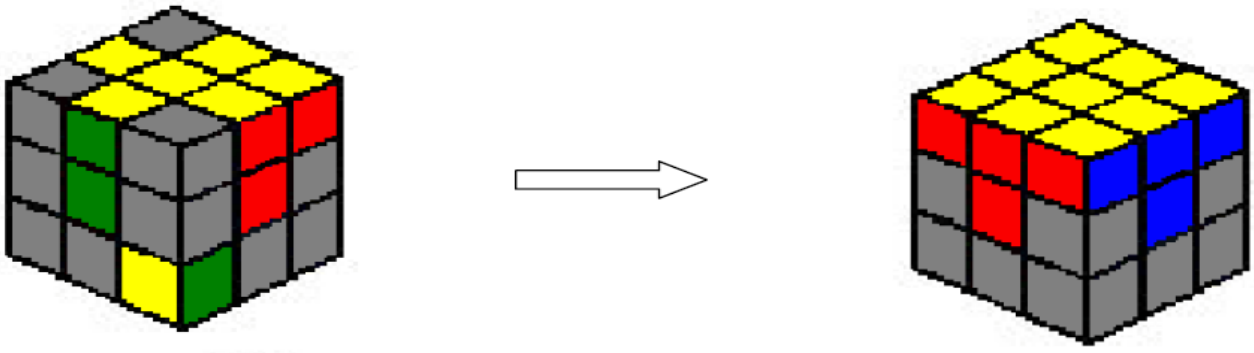
The Corners



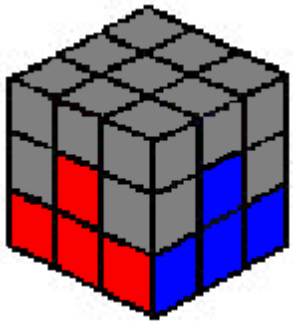
Place the Corner Piece below the correct corner and perform algorithm 2 as many times as necessary. Notice that the corner piece shown corresponds to the spot two spaces above it. It does not matter how it is currently aligned, just that it is the right piece. It may require multiple repetitions of the algorithm to get it in the right position. Remember to keep the same face during each repetition.

1) Ri Di R D

Proceed with the other corners performing algorithm 2 for each. Remember to hold the cube with the missed aligned piece in the lower right corner of the top face. If correctly done, you should now have the upper face and the first layer completely solved, as shown below:

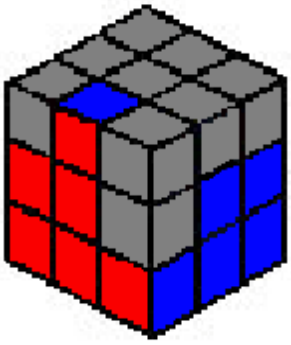


Flip the Cube such that the Yellow Top is now on the Bottom. Now you're ready to start solving the middle layer.

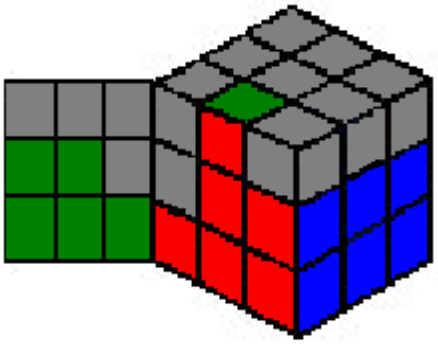


Middle Layer Edges

There is a possibility of 4 unsolved edge pieces in the middle layer. To start solving the middle layer, turn the top face until the colors match and the top color matches with the left face or right face. There are two different moves that are important, moving the top edge piece to the right or to the left. The example covers both moves. The 3rd algorithm will be used to move right while the 4th algorithm will be used to move left.

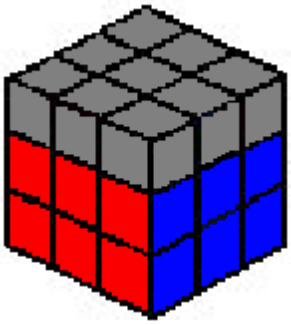


3) U R Ui Ri Ui Fi U F



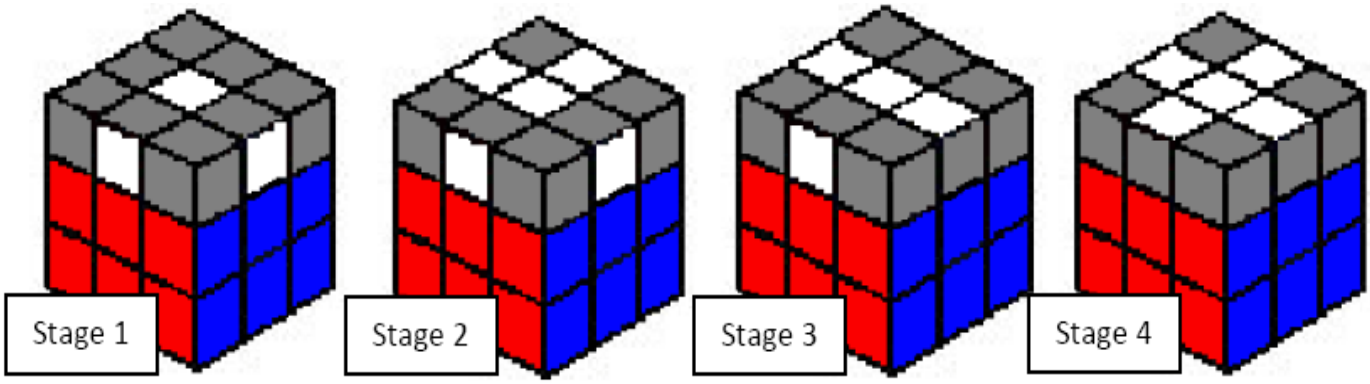
4) Ui Li U L U F Ui Fi

Continue solving each middle edge piece until you have solved them all. Remember to hold the cube with the front face that has the middle edge piece to move.



The Plus Sign

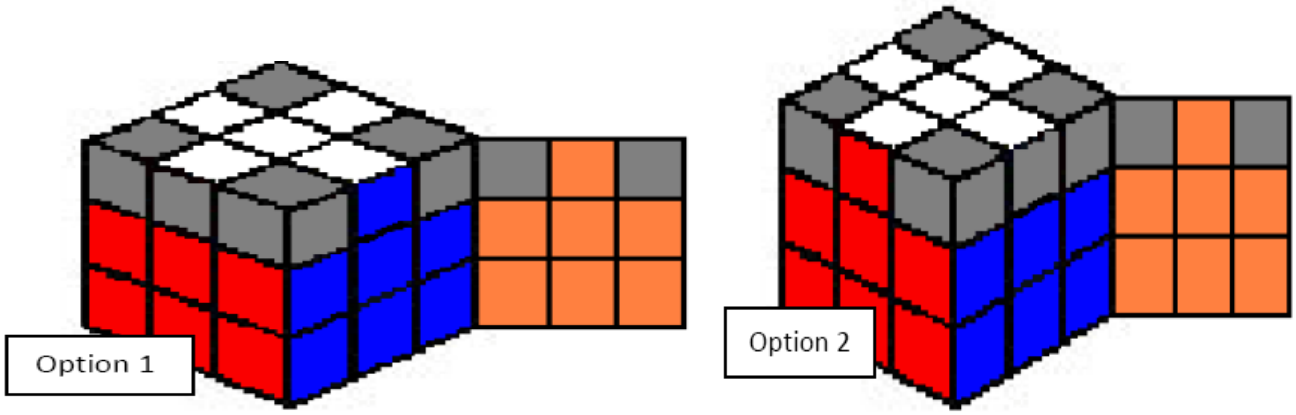
Turn the top face until one of the following patterns is seen. Determine your face from the figure and perform algorithm 5. You may be on any stage and you will progress through the stages as you perform algorithm 5. You shouldn't have to perform algorithm 5 more than three times to make a plus sign.



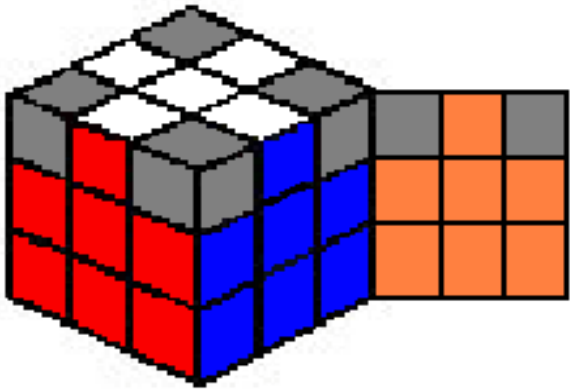
5) F R U Ri Ui Fi

Middle Center

Now you must turn the top until two of the center edge pieces align. You will have two options; hold the cube in your hand with the correct front facing you like in the diagrams. In order to perform algorithm 6 correctly, the cube needs to have the diagrams front face. All 4 center edge pieces should be aligned correctly. This algorithm shouldn't be performed more than twice.

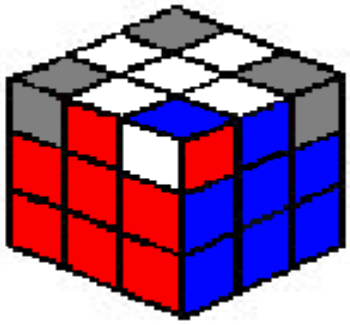


6) R U Ri U R U U Ri



The Corners

There should be at least one corner piece in the correct place, but not necessarily aligned correctly. Hold the cube with this piece in the lower right corner of the top face. Now it's time to perform algorithm 7.



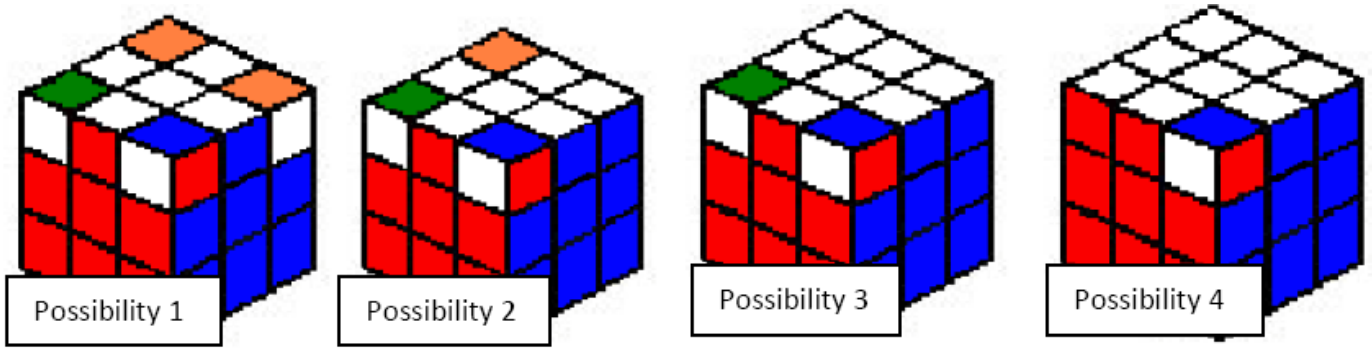
This will place all the corner pieces in the correct spot but not aligned correctly. This may be performed up to three times. If there is no pieces in the correct place, then perform algorithm

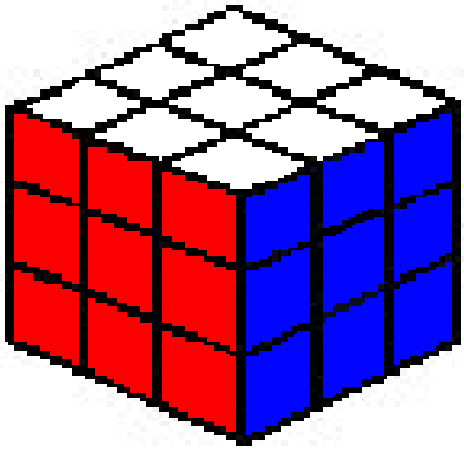
7 with any face as the front except for the top or bottom faces. Now there should be one that is in the correct corner. Find it and place it in the lower right corner of the top face.

7) U R Ui Li U Ri Ui L

One of the following will occur, hold the cube with the unaligned piece in the lower right corner of the top face. Perform algorithm 8 two to four times. Watch for the piece to match, at that moment you will need to rotate the top face once CCW and perform algorithm again. Remember to keep the same front face throughout the rotations. You will have to repeat this for as many times as you had unsolved corner pieces.

8) Ri Di R D





CONGRATULATIONS!

Invent, play and inspire! Thank you!

Determine Your Birthday-Math Number Trick

Just follow the steps with a calculator or *by hand for building math skills!* Go ahead and try the trick without cheating!

- **Add 18 to your birth month**
- **Multiply by 25**
- **Subtract 333**
- **Multiply by 8**
- **Subtract 554**
- **Divide by 2**
- **Add your birth date**
- **Multiply by 5**
- **Add 692**
- **Multiply by 20**
- **Add only the last two digits of your birth year**
- **Subtract 32940 to get your birthday!**

The answer's format is: month/day/year. For example, an answer of *123199* means that you were born on December 31, 1999. If the answer is not right, you followed the directions incorrectly or lied about your birthday.

How to multiply big numbers by 5

Take any number, then divide it by 2**. Then…**

If the result is whole **(that is, theres's no remainder),** add a 0 **at the end.**

If it is not whole, ignore the remainder and add a 5 **at the end of the number.**

For example, 4252×5 = (4252/2) and add a 5 or 0 to the end of the number

4252/2 = 2126 (it's a whole number so add a 0 to the end)

The answer… 21260

How to multiply by 4

The trick here is to simply multiply by two, then multiply by two again. Ultimately, you want to work with smaller numbers that are easier to work with in your head.

For example 82 x 4 = (82 x 2) x 2 = (164) * 2 = 328

Substracting a large number from 1000

To subtract a large number from 1000 you can use this basic rule: subtract all but the first number from 9 (taking the absolute value… that is, ignoring if the number is negative), then subtract the last number from 10:

1000
– 736

Step 1: subtract 7 from 9 = **2**
Step 2: subtract 3 from 9 = **6**
Step 3: subtract 6 from 10 = **4**

Your answer: **264**

Power multiplication or square of a number that ends in 5

Here the speed would really amaze you. Try finding the square of 85 in your head. How much time did it take you? Now try this fast math trick here.

1. Ignore 5 in the units place
2. Take the digit in the tens place i.e. 8 and multiply it with its successor i.e. 8+1 = 9. The result is 72
3. Simply place 25 at the end of the result i.e. 7225. Thats it. 7225 is the square of 85. That is your answer.

Wasn't that fast math trick? This math trick can be used anytime you have to find square of a number ending in 5. It works with 3 digit numbers too. So the square of 135 is ..... first multiply 13 with its successor i.e. 14 = 182. Now add 25 at the end. Your answer is 18225.