Rubik's 2x2x2 Pocket Cube

First patented by Rubik 1983, other patents cover different internal mechanisms.
(plastic, 1.5 inches)

Rubik 2x2x2 Three Step Solution

Notation: L (left), R (right), F (front), B (back), U (up), and D (down)
for 90 degree clockwise rotations of that face; - means counterclockwise.
Corners are named with three letters.

1. Solve the down layer.

2. Put up the layer corners in correct locations (but possibly rotated incorrectly):
   Use the following sequence exchange two corners:
   
   UFL <-> UFR:  \((F \ U) \ (F- \ U-) \ (L- \ U- \ L)\)
   
   Note: A quick way to do UBL <-> UFR is to precede this by L and skip the final L.

3. Fix the up layer so all corners are rotated correctly:
   Position the cube so the up front right corner is not correct and repeat these two steps
   until all up corners are correct:
   
   A. Repeat until the up front right corner is correct:

   \((R- \ D-) \ (R \ D)\)
   
   B. Rotate the up layer so the up front right corner is not correct.

Note: During Step 3, the down layer will be mixed up, but it will become correct again at the end. Be sure to do all four moves of Step 3A each time; it is easy to forget the final D when you see the correct color on top.
Notes About The Rubik 2x2x2 Three Step Solution

**Step 1:**
Get three corners right, move two of the correct ones 90 degrees, move the fourth into position, and move the two correct ones back. If the 4th corner is rotated so it won't position correctly, do a full 180 degree turn of that side and then you can reposition it to try again. In any case, even if this description is hard to follow, after playing a bit, this step becomes easy.

**Step 2 - a simpler but slower randomized solution:**
As summarized on the next page, this step could be replaced by:

*Step 2.* If possible, rotate the up layer to be correct, except some corners may be rotated; otherwise, mix up and go back to Step 1 using a different color on the bottom.

(Starting from a random position, there is a 1 in 6 chance that this test succeeds. So even if a quick mix and starting with a different bottom is not completely random, once you get reasonably fast at doing Step 1, it shouldn't take too long.)

**Step 2 - making it faster:**
This step can be used three times for a diagonal exchange. However, since it does not change the upper back left corner, it is faster to do UBL <-> UFR by preceding the transformation with L and skipping the final L.

**Step 3 - making it faster:**
Every iteration of the corner rotator exchanges UFR and DFR, and repeating it 6 times returns the cube to exactly where it was. Step 6A will use the corner rotator 2 times if the top color is on the right side of the UFR corner, but 4 times if it is on the front, in which case it is faster to do the reverse sequence 2 times:

*reverse corner rotator: D- R- D R*

**Step 3 - why it works:**
- Step 3A affects only 4 corners by exchanging two front right corners and also exchanging the two back down corners.
- Doing Step 3A twice leaves corners in the same positions, except those four corners are rotated, and doing Step 3A six times leaves the corners the same as when you started.
- On the up layer Step 6 only modifies the front right corner.
- Since Step 3 started with the bottom corners correct, once three of the four top corners have been fixed, fixing the fourth top corner must leave the bottom corners correct. This is because when at every 6th move the two back bottom corners are correct, all that is left that could be incorrect are the two front right corners, but due to parity considerations, a completely solved puzzle except for two adjacent rotated corners is not possible.
- This transformation also works for a Rubik 3x3x3 cube (and is the last step of the layer by layer solution presented on that page). The only edge pieces that are affected are FR, RD, BD, which are on the lower two layers; they return back to where they were after 6 moves.

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1. Solve the bottom layer.

2. If possible, rotate the top layer to be correct, except some corners may be rotated; otherwise, mix up and go back to Step 1 using a different color on the bottom.

3. Fix the top layer so all corners are rotated correctly:
   Reposition the cube so the top front right corner is not correct, and repeat these two steps until all up corners are correct:

   A. Repeat until the top front right corner has the correct color on top:

   \[(R- D-)(R \ D)\]

   Where \(R\) and \(D\) mean to rotate the right and down (bottom) layers 90 degrees clockwise, or \(R-\) and \(D-\) mean to rotate the right and bottom layers counterclockwise.

   B. Rotate the top layer 90 degrees counterclockwise.
Rubik 2x2x2 Three Step Solution - Another Way Do Step 2

The randomized solution described on the previous page, that simply hopes for the 1 in 6 chance to skip Step 2, can be a bit unsatisfying. It's not hard to learn the sequence of Step 2, but it is interesting to note that you don't have to. Instead, we can borrow the sequence from Step 3A, which we call $S$, and its reverse $S$-:

$$S = (R-D) (R D)$$
$$S- = (D-R) (D R)$$

Consider interleaving a do-nothing sequence of $U$'s into a do-nothing sequence of $S$'s:

- do nothing with two $S$'s followed by two $S$'s
- do nothing by rotating the top layer 360 degrees
- bottom layer unchanged but top layer is modified

Here is how this sequence cycles three corners A,C,D on the top layer (and the cube is returned to where it was if you do it three times), or if it is followed by a $U$, it exchanges two corners B and C on the top layer (X denotes the corner below A at the start):

Although the sequence is relatively long when each $S$ is expanded to the corresponding four moves, once you understand how $S$ works, it is easy to remember this alternate Step 2:

2 (alternate). Fix the up layer so all corners are rotated correctly:

Let $S$ be the sequence of Step 3A. Below is $S S S$- $S$- interleaved with $U U U^2$; use it to keep the up left front corner and cycle the others, or to exchange the two up left corners, follow it with a $U$:

$$S U S U S- U^2 S-$$

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Another Three Step Solution

The booklet that comes with the Homer Simpson version describes a three step solution using these sequences:

(From the booklet that came with Rubik 2x2x2 Homer Simpson.)

With the notation from the preceding page (where 2 means do it twice), these transformations can be expressed as:

**Step 2:**

FRD <-> BLD: \[ \text{F} \ \text{L} \ \text{D} \ \text{L}^- \ \text{D}^- \ \text{F}^- \ \text{D}^- \] ("diagonal swapper")

FRD -> BLD -> BRD -> FRD: \[ \text{B} \ \text{L} \ \text{D}^- \ \text{B}^- \ \text{L}^- \ \text{D}^- \ \text{L}^- \] ("shunter")

**Step 3:**

FRD-, BRD-, BLD-: \[ \text{R}^- \ \text{D}^- \ \text{R} \ \text{D}^- \ \text{R}^- \ \text{D}^2 \ \text{R} \ \text{D}^- \ \text{R}^2 \text{D} \] ("shifter")

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Other Sequences For Faster Solutions

The solutions presented on the preceding pages employ transformations that may have to be used several times. Jaap's Page presents a solution that uses fewer moves by employing a different transformation for each of the possible situations that may occur.

Notation: R (right), F (front), and D (down) for 90 degree clockwise rotations of those faces, and - for counterclockwise instead of clockwise. A 2 means do it twice. Corners are denoted with three letters (e.g., BLD = back left down corner).

Sequences for exchanging corners:

FLD <-> FRD:  F  D  F-  D-  R-  D-  R
FLD <-> BRD:  R  F  D  F-  D-  R-  D-
FRD <-> BLD:  F-  R-  D-  R  D  F  D-

Sequences for rotating corners (+ / - denote clockwise or counter clockwise):

FLD-, BLD+:  R-  D-  R  F-  D  R  D  R  D2  F2
FLD+, BLD-:  F2  D2  R-  D-  R  D-  F  R-  D  R
FLD-, BRD+:  R2  D-  R  D2  R-  D2  R  D-  R2  D
FRD-, BRD-, BLD-:  R-  D-  R  D-  R-  D2  R  D2
FRD+, BRD+, BLD+:  D2  R-  D2  R  D  R-  D  R
FRD-, BRD+, BLD-, FLD+:  R2  D2  R  D2  R2  D
FRD+, BRD-, BLD-, FLD+:  R  D  F  R2  D2  F2  D  F-  D  R2

These transformations are done from the point of view of the top layer solved and then solving the bottom layer, because it makes the puzzle easier to hold with the left hand and manipulate with the right hand (no moves of the up, left, or back layers needed).

Jaap's Page presents the above transformations along with many more, including transformations to make specific patterns.

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Rubik's 2x2x2 - 25 Years Later

Plastic, stickerless, made in China, purchased from Amazon.com in 2015.
(DaYan, sold by Maxin, comes in a fitted box, 1.8" square)

In the early 2000's, smoother working versions of Rubik's 2x2x2 were widely available, with screws / springs for adjustable tension and smooth turning even when layers are not exactly aligned (beveled interior corners in conjunction with the spring action give a minimal degree of automatic alignment). Even dimension Rubik cubes, of which the 2x2x2 is the smallest, don't use a central axis like standard odd dimension designs such like the Rubik's 3x3x3 cube. Here are photos of the one shown above apart:

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Rubik's 2x2x2 Star Wars

The Darth Maul figure is large (4 inches high) with a smooth mechanism. The others are small (between 2.25 and 2.5 inches high) from Kellogg's cereal boxes in the 2002 time frame; each has two related Star Wars Episode II figures, one on each side.
Rubik's 2x2x2 Cartoon Characters

Mickey Mouse
(Disney, Spain, circa 1990?, 5”, sold by Mefferts 2006)

Donald Duck
(Disney, Spain, circa 1990?, 4”)

Bugs Bunny
(Warner Brothers, 1999, PUZZLE HEADZ LTD, 3.5”)

Scooby Doo
(Warner Brothers, 1999, PUZZLE HEADZ LTD, 3.75”)

Batman
(Warner Brothers 1999, PUZZLE HEADZ LTD, 3.75”)

Joker
(Warner Brothers 1999, PUZZLE HEADZ LTD, 4”)

Tom
(Warner Brothers, 1999, PUZZLE HEADZ LTD, 3”)

Jerry
(Warner Brothers, 1999, PUZZLE HEADZ LTD, 3”)

Tasmanian Devil
(Warner Brothers, 1999, PUZZLE HEADZ LTD, 3.25”)

Tweety
(Warner Brothers, 1999, PUZZLE HEADZ LTD, 2.75”)

Mars Marvin
(Warner Brothers, 1999, PUZZLE HEADZ LTD, 3.25”)

Hanshin Tigers
Japan Baseball
(circa 2000, 3”)

Homer Simpson
(circa 2000, 5”)

Bart Simpson
(circa 2000, 4.5”)

Dog, Kitty, Penguin
(China, 2006, all three are 4.25”)

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Rubik's 2x2x2 Other Versions

Rubik's Pocket Cube (1980's, 1.5")
Eastsheen (2006, 2")

Tiny Size (2006, 1")
Keychain (2006, 1")

2007 Calendar Cube (2")
Rubik's Junior (2006, 1.5")

Popeye (1980's, 2.2")
Smaller Size Popeye (1980's, 2")

Harry Potter (circa 2000, 2.25")
Australian Road Signs (circa 2000, 2.25")

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Rubik's 2x2x2 Further Reading:


Li Patent, (Eastsheen Mechanism) from: www.uspto.gov - patent no. 5,826,871


Khoudry International Patent (K-Ball), IP25874.

Kremmer Patent (Darth Maul), from: www.uspto.gov - patent no. 6,217,023

Nicholas Patent (uses magnets), from: www.uspto.gov - patent no. 3,655,201