

DIRECTIONS FOR SOLVING THE RUBIK'S CUBE

These instructions can be used to solve a 3x3x3 [Rubik's Cube](#) and also a 2x2x2 [Rubik's mini cube](#) starting from any combination of colors on a mixed up cube. The instructions are both easy to follow and easy to memorize. Furthermore, the approach to solving the cube I take seems to be different than [others](#) on the web. If you have had problems with other solutions, I would suggest mine since it is foolproof and is only four easy steps (though I divided three of them up into two parts). I would appreciate any and all feedback or questions about the instructions; please see the end of this page for the e-mail address.

I have recently learned that the solution I describe was popularized by Minh Thai, the National Champion cube solver whose record Time in late 1981 was 26.04 seconds (he was on the TV show "That's Incredible"). He went on to publish a booklet entitled "The Winning Solution" (1982), talking about his method for solving the cube, a "corners first" approach, based on the solution presented by Ideal Toy Company (The Ideal Solution, 1980), the book which I believe I learned this solution from. (Information from the [Rubik's FAQ](#) and from Philip R. Marshall's [comparison page](#), comparing various solutions.)

Note: I also have [instructions](#) for how to solve a cube when it has pictures on each face. By putting a picture on each face, or even a small logo on the middle-center piece of each face, the orientation of the middle-center pieces becomes significant in order to show the picture correctly. Various moves are described to correct for this problem.

Purchasing Puzzles: If you are having troubles finding stores that sell cubes and similar puzzles, I have a list of [on-line sites](#) that may have what you're looking for.

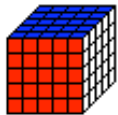
My other cube pages



See [Denny's solution](#) for solving the 3x3x3 cube. This is a more detailed solution for the 3x3 than the one I provide (mirrored from the now missing <http://www.calormen.com/vpm/puzzlesolutions/rubikscube/>)



See [Denny's solution](#) for solving the 4x4x4 cube (mirrored from the now missing <http://www.calormen.com/vpm/puzzlesolutions/revenge/>)



[My directions for Solving the Professor Cube \(5x5x5\)](#)



[My directions for Solving the Square 1](#)



[My directions for Solving the Pyramix \(Pyramid\)](#)

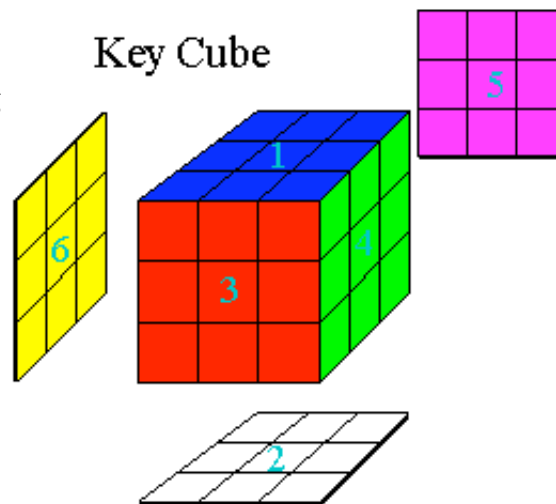
As a preview, the steps are:

- [1.](#) Solve the top
- [2.](#) and [3.](#) Correctly position and orient the bottom four (remaining four) corners
- [4.](#) and [5.](#) Complete the bottom
- [6.](#) and [7.](#) Correctly position and orient the four remaining middle edge pieces.

NOTE: Only steps 1 through 3 are required for solving a 2x2x2 cube. Furthermore, you only need to match up the corners of the 2x2x2 cube with the corners of the 3x3x3 cube in the diagrams, and the directions will apply perfectly.

KEY TO SYMBOLS FOR THE MOVES

The figures in this document represent a sample cube. Although the colors on your personal Rubik's cube may be different than the figures, I feel that the colored figures will still be helpful in solving the cube. I would suggest matching as many colors on your cube as possible to the figures, then making mental notes about which colors correspond between your cube and the figures. For example, perhaps you can match the red, green, and blue sides exactly, but the yellow in the figures corresponds to pink on your cube. Just keep this equivalency in mind when looking at the figures. In addition, I have numbered the middle-center pieces for reference such that 1 and 2 are opposite each other and 3, 4, 5, and 6 go around the cube in a circle. Finally, the diagrams show all six sides of the cube by pretending that **mirrors** are being held up so that you may see the "hidden" sides. If you have trouble discerning the difference between green and yellow, try this [alternative page](#).



The directions for what parts of the cube to turn and when are given in a code that is *relative to the current positioning* of the cube. Each side or slice descriptor refers to a side with respect to the figure the move is referenced to. This means that the front side can be a different color, depending on the diagram being used. The code is easy to follow and instructive diagrams are included for each of the moves.

The Letters:

The side descriptors are:

- **U** for the top (Upper) side
- **L** for the left hand side
- **F** for the front side

The slice descriptors are:

- **H** for the horizontal slice (between the top and bottom sides)
- **V** for the vertical slice (between the left and right sides).

Although the directions are relative to the current positioning of the cube, the numbers assigned to each side always stay with the same color/side they were originally assigned.

If you are wondering what symbols are used for the bottom, right, and back, I haven't left them out. The main directions do not

reference these sides, so I won't assign them symbols.

The Numbers:

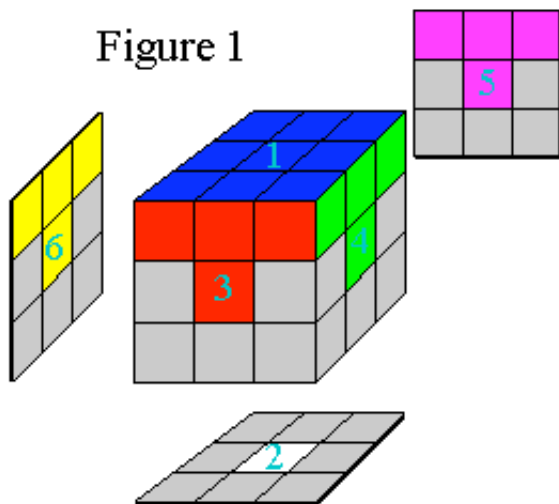
The numbers tell you which direction to rotate a given side or slice and how many times to rotate it: 1 for one quarter turn clockwise, -1 for one quarter turn counterclockwise, and 2 for two quarter turns (half way around).

- For example, U F2 L-1 means to rotate the upper side clockwise one quarter turn, the front side clockwise twice (half way around), and the left side counterclockwise one quarter turn. Look directly at the specified side indicated to determine which direction is clockwise or counterclockwise.
- For the vertical slice, V, look at the cube **through the right side** to determine the clockwise direction.
- For the horizontal slice, H, look at the cube **through the top side** to determine the clockwise direction.

To further clarify this notation, each of the moves has detailed accompanying figures to better describe them. Simply click on a figure to see the moves graphically.

In the figures, any gray pieces represent pieces that don't matter and can be any color. To increase clarity, I have shown a lot of colored pieces. In most cases, the figures represent an example of the situation being described, while the colors don't have to match perfectly, particularly when I describe correctly positioned yet incorrectly rotated pieces. Wherever I have placed numbers on the pieces in the figures, though, they should match up perfectly.

• Step 1: Solve the top side of the cube (Side 1 in the figures)



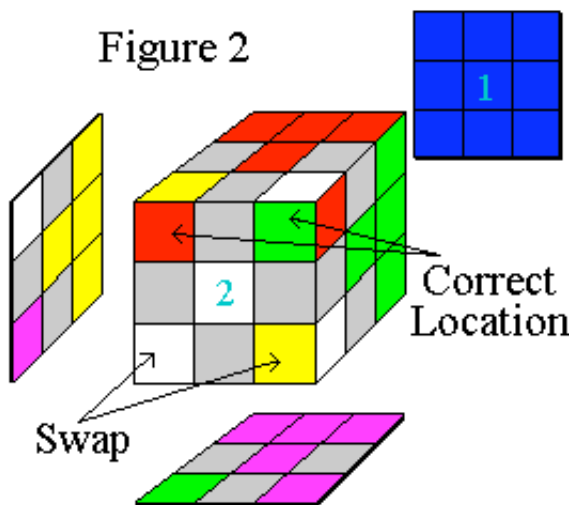
Pick a middle-center piece to represent the first side of the cube solved (side 1 in the diagrams) and solve that side (make it a solid color). *Be sure to have correctly colored and matched edge and corner pieces, such that an evenly colored border exists around the side, as shown in Figure 1.*

Hopefully you can accomplish Step 1 without any help from me. It's just a matter of moving pieces out of the way to insert desired pieces in the correct locations. Still, if you would like further help on this, follow me to the [Step 1 page](#).

• Step 2: Position the 4 corner pieces of Side 2

- Check the bottom four corner pieces (Side 2) to see which are in the correct location to match up with the three adjacent middle-center pieces. Note that the pieces being examined need not have the correct orientation (matching colors touching), they need only be positioned correctly (correspond to the correct colors). For example, in Figure 2, the white-red-green corner piece is correctly positioned but not correctly oriented while in Figure 5 it is correctly positioned and also correctly oriented.
- Finding how many of the bottom four corner pieces are correctly positioned requires rotating side 2 (the white side) until two or four pieces are in the correct position. One of the four positions of side 2 will always have two or four pieces correctly positioned. Although you may see cases where one or three pieces are correctly positioned, you need to ignore those cases. Just keep rotating side 2 and you should eventually see at least two pieces in the correct position.

2a. If the two corners in the correct position are parallel (in line on the same edge):

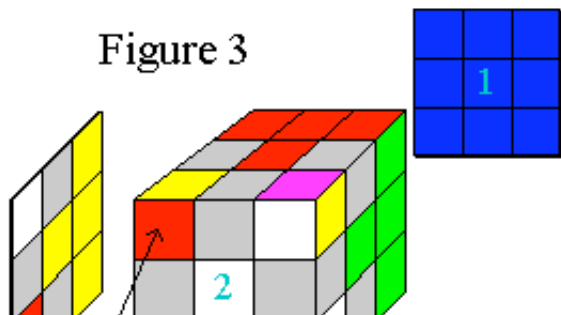


Orient the cube as shown in Figure 2 where the two corner pieces in the correct position are at the front-top corners of the cube and the two corner pieces in the incorrect position are at the front-bottom corners of the cube. Perform Move 1, then proceed to [step 3](#).

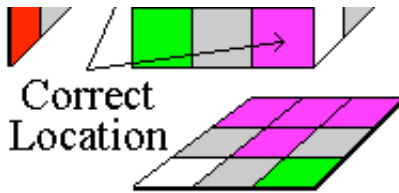
Move 1: U-1 F U L-1 U L U-1 F2

- In words, rotate the upper side (red here) one quarter turn counter-clockwise, then the front side (white here) 1/4 turn clockwise, then the upper side 1/4 turn clockwise, then the left side (yellow here) 1/4 turn counter clockwise, etc.
- If this notation is still confusing, click on Figure 2 to see example figures demonstrating the move.

2b. If the two corners in the correct position are diagonal to each other:



Orient the cube as shown in Figure 3, with side 1 in the back and either of the correctly positioned corners in the top-left-front and bottom-right-front positions. Perform Move 1,

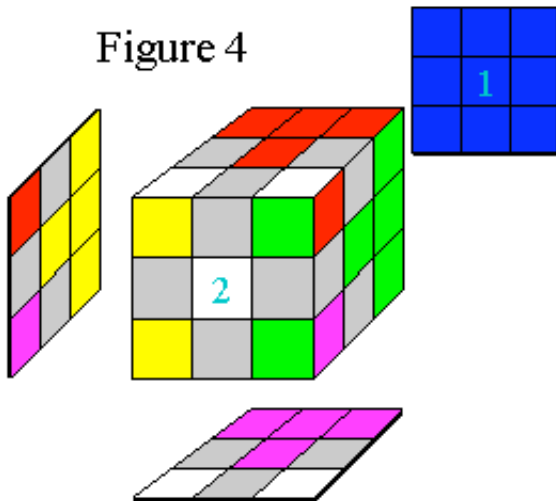


then go back to [step 2](#), progressing to step 2a after correctly rotating Side 2 as instructed.

• Step 3: Orient the four corner pieces of Side 2

Examine side 2 of the cube. Zero, one, two, three, or even four of the corner pieces will be oriented correctly such that they perfectly line up with their adjacent middle-center pieces. If all four are correct, the cube should look as shown in [Figure 8](#) (below). If not:

3a. For zero correctly oriented pieces:

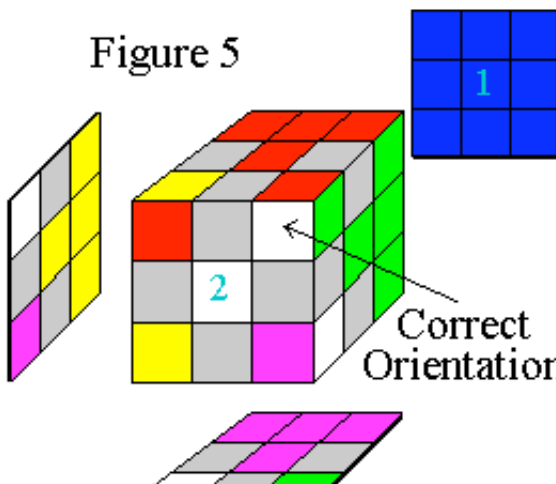


Position the cube as shown in Figure 4 such that Side 2 is facing you. Perform Move 2, then return to the start of [step 3](#).

Move 2: U-1 F2 U F U-1 F U F2

In words, rotate the upper side (red here) one quarter turn counter-clockwise, then the front side (white here) two quarter turns (half-way around), then the upper side 1/4 turn clockwise, etc.

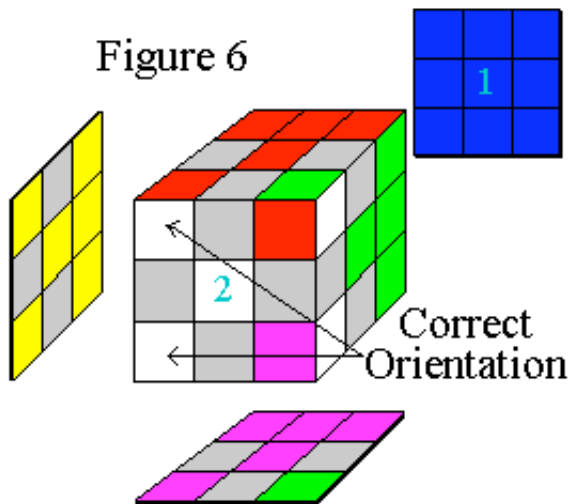
3b. For one correctly oriented piece:



Position the cube as shown in Figure 5. Perform Move 2, then return to the start of [step 3](#) only if the four corner pieces of side 2 are not oriented correctly. If they are correct, as shown in [Figure 8](#), go to [step 4](#).

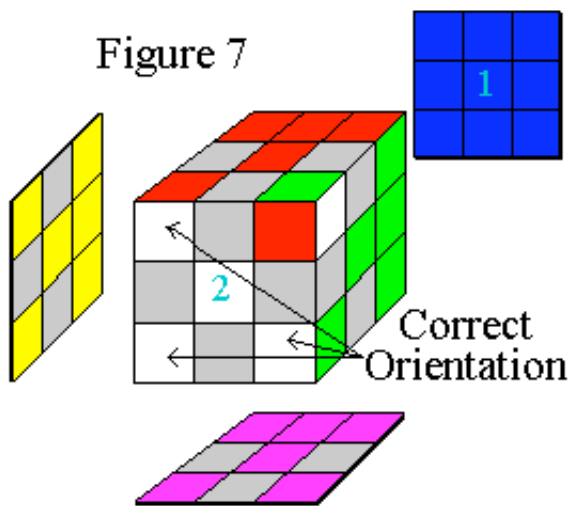


3c. For two correctly oriented pieces:



Position the cube as shown in Figure 6. Perform Move 2, then return to the start of [step 3](#).

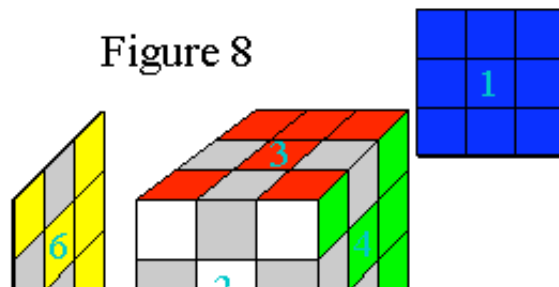
3d. For three correctly oriented pieces:



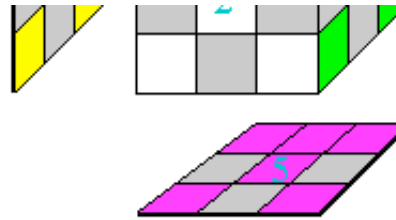
It is not possible to have 7 corners oriented correctly while just one is incorrect. If your cube is in fact like this then it has been disassembled in the past and incorrectly reassembled. You will have to disassemble it again and reassemble correctly.

NOTE: Step 3 may need to be repeated numerous times. Also, the move directly before all four corner pieces are oriented correctly will have just one piece oriented correctly, as shown in [Figure 5](#) (step 3b).

- This does not mean, however, that you will always achieve Figure 8 when just one piece is oriented correctly. Again, just keep repeating step 3 until Figure 8 is achieved. It will happen, trust me. Move 2 is sort of a black magic move, but it works.



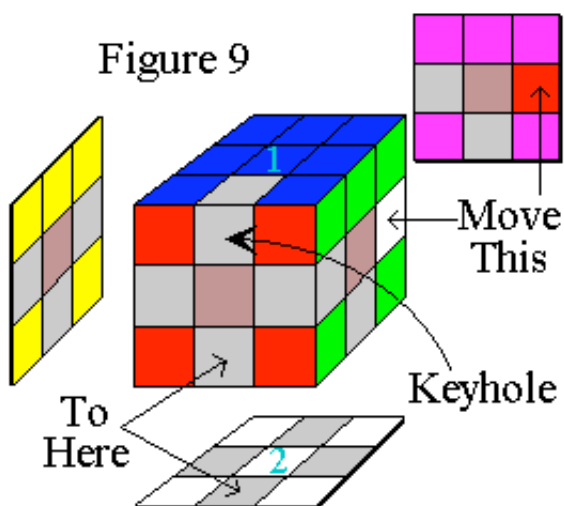
- If you end up performing Move 2 over 10 times, either some of the corners on side 1 (the blue side) are incorrectly twisted or you're not setting up the cube as shown in the figures.



NOTE: To achieve the image shown in Figure 8, the slice containing middle-center pieces 3, 4, 5, and 6 may need to be rotated. Side 2 may also need to be rotated.

• Step 4: Complete side 2

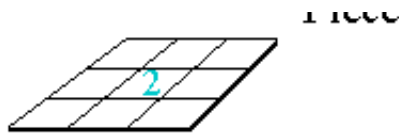
- The four remaining pieces for side 2 should be scattered throughout the unsolved portion of the cube. To insert each piece, set up the cube by rotating the center slice (between the blue and white sides) to position the desired piece as shown in Figures 9 or Figure 10, then follow the directions given. In the figures, the piece to be inserted is the Red-White middle edge piece. The move will insert it into side two, orienting it in the correct way.
- There are two different moves, since the piece could initially be positioned one of two ways. In both moves, the piece to be positioned moves through the **keyhole** -- a hole we'll make in the already solved blue side to allow pieces to pass through it without disturbing the rest of side 1. The first time you use Move 3 or Move 4 you will remove a piece from side 1 and create the keyhole. From then on, use the keyhole as directed below to move pieces through it and leave side 1 undisturbed.
- In order to get your cube to match Figure 9 or Figure 10, you will need to rotate side 2 (the bottom) **and** the center slice, putting the piece to be positioned on the back right, and the spot where it goes in the front.



If the cube looks like Figure 9, then Move 3 will put the piece into place.

Move 3: F H2 F-1

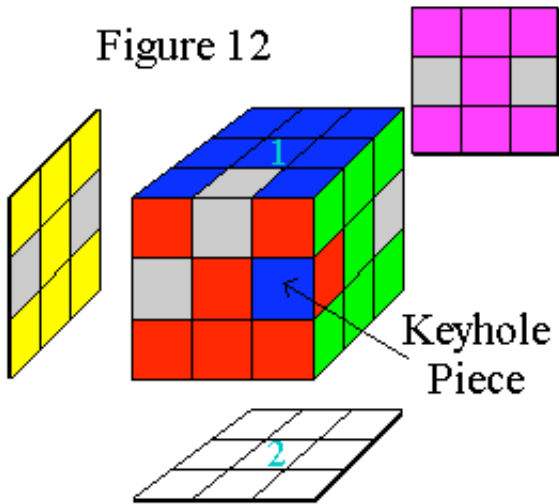
In words, rotate the front side (red here) one quarter turn clockwise, then the middle horizontal slice (containing the red, green, pink, and yellow middle-center pieces) two quarter turns (half-way around), then the front side one quarter turn counter clockwise.



Move 5: F H-1 F-1 H-1 F H F-1

In words, rotate the front side (red here) one quarter turn clockwise, the middle horizontal slice (between the blue and white sides) one quarter turn counter clockwise (so that the red/blue corner piece moves toward the back), the front 1/4 turn counter clockwise, etc.

Figure 12



If the cube looks like Figure 12, then Move 6 will put the piece into place.

Move 6: F H-1 F-1 H2 F-1 H-1 F

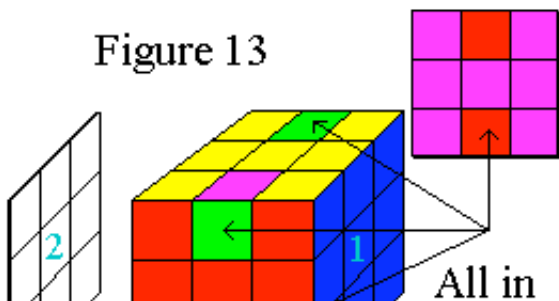
In words, rotate the front side (red here) one quarter turn clockwise, the middle horizontal slice (between the blue and white sides) one quarter turn counter clockwise (so that the red/blue corner piece moves toward the back), the front 1/4 turn counter clockwise, etc.

• **Step 6: Position the four remaining pieces**

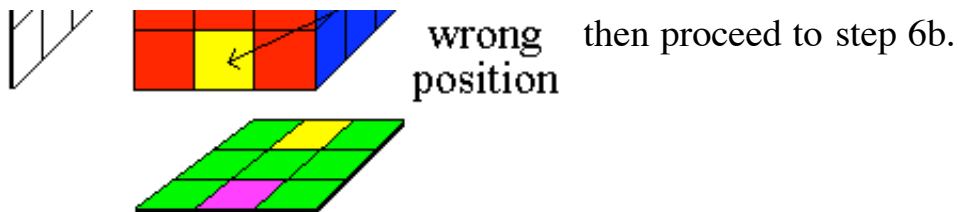
Position the cube as shown in Figure 13, with side 1 on the right. Now the slice we have been calling the middle horizontal slice has become the middle vertical slice, V. Rotate the middle vertical slice and side 2 until each middle-center piece matches up with its corresponding side 1 and side 2 edge and corner pieces. Examine the four remaining center-edge pieces.

6a. If none of the four center-edge pieces is in the correct position:

Figure 13



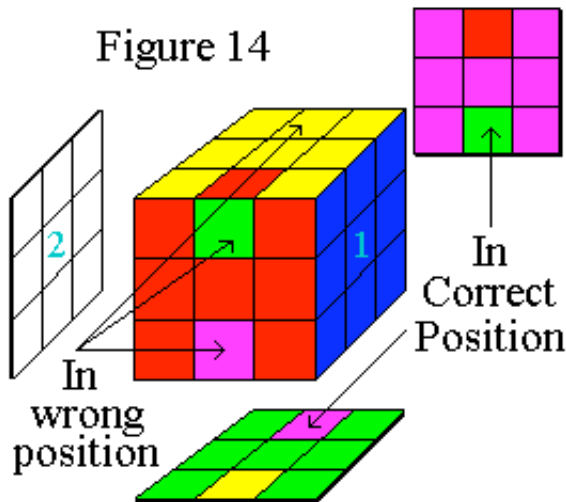
Position the cube as shown in Figure 13, placing side 1 on the right and side 2 on the left (the rest don't matter here). Perform Move 7,



Move 7: V U2 V-1 U2

In words, rotate the middle vertical slice (between the blue and white sides) one quarter turn clockwise (away from you), the top side (yellow here) two quarter turns (half-way around), the vertical slice 1/4 turn counter-clockwise (back toward you), and the top half-way around again.

6b. If just one of the pieces is in the correct position:



Position the cube as shown in Figure 14, placing the correctly positioned (not necessarily oriented) center-edge piece to the back of the cube so that it cannot be seen. Perform Move 7, one, two, or three times until each center-edge piece is in the correct position. Proceed to step 6d.

6c. If **two pieces** are in the correct position, but are diagonal to one another, then position the cube as shown in [Figure 16](#), perform Move 8, and proceed to [step 7a](#).

6d. When all four center-edge pieces are correctly positioned, proceed to [step 7](#).

• Step 7: Orient the four center-edge pieces

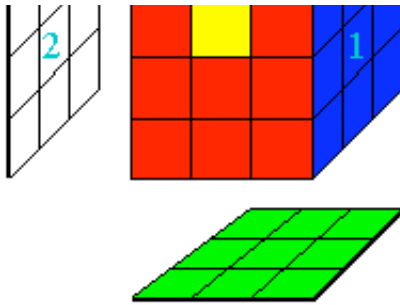
The following "Rube Move", named after Mr. Rubik himself (since he formulated it), will flip the two center-edge pieces on the top side of the cube shown in Figure 15.

If two center-edge pieces are correct and the two that are wrong are diagonal to each other then perform step 7b and proceed to step 7a.

7a. For parallel misoriented pieces:



First orient the cube so that the two misoriented center-edge pieces are on the top side of the



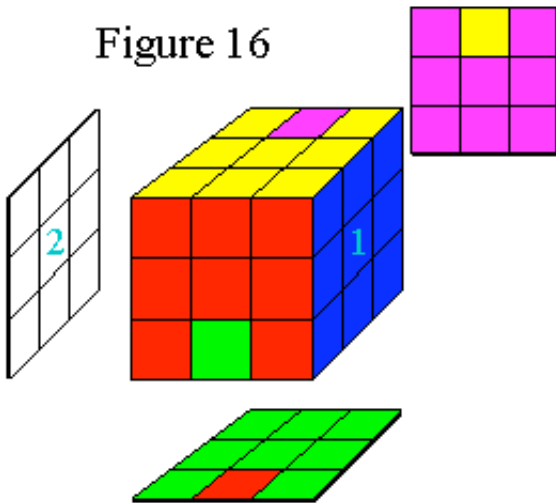
cube as shown in Figure 15 and perform Move 8. Next, place the remaining two center-edge pieces in the top positions and, if misoriented, perform Move 8.

Move 8: V U V U V U2 V-1 U V-1 U V-1 U2

In words, rotate the middle vertical slice (between the blue and white sides) one quarter turn clockwise (away from you), the top side 1/4 turn clockwise, the vertical slice 1/4 turn up, the top 1/4 turn clockwise, the vertical slice 1/4 turn up, the top two quarter turns (half-way around), the vertical slice 1/4 turn counter-clockwise (back toward you), the top 1/4 turn clockwise, etc.

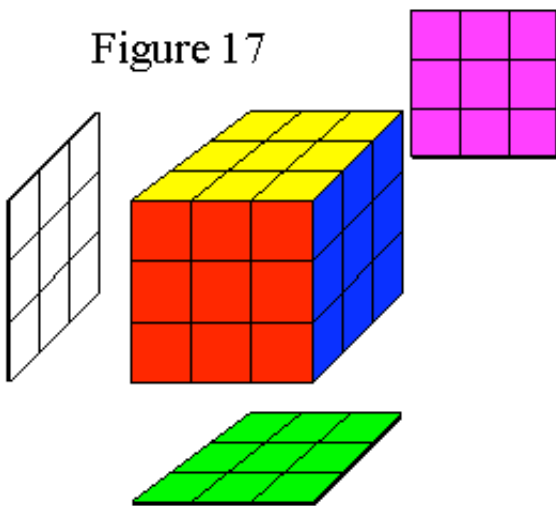
7b. For diagonally misoriented pieces:

Figure 16



Position the cube as shown in Figure 16. Rotate the front (red side) two turns (F2), perform Move 8, then rotate the front two more turns (F2). You are essentially making the cube look like Figure 15, then using Move 8, then re-orienting the front pieces.

Figure 17



Congratulations, you've solved the cube.

If you have pictures on the faces of your cube, or a logo on the middle-center piece of each side, see [these](#)

[instructions](#) for extra help.

I hope you have found these directions to be clear and complete, yet concise. If these directions help you to solve the cube, I would enjoy hearing from you. If you have any questions, I would be happy to help you in any way possible.

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