

# How to solve a Rubik's Cube

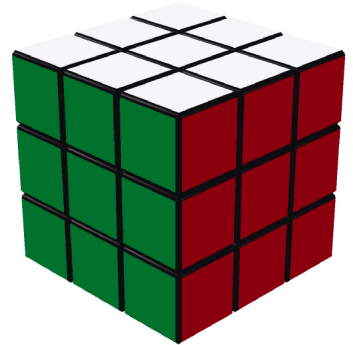
## Introduction and Notation

In this tutorial you will learn Rubik's cube notation and the basic solution to a cube. You will be learning a method that can easily be "upgraded" into a speed cubing method.

You will need only two things for this tutorial: a cube and patience. As for the cube there is a strange phenomenon in the cubing community; the cheap Chinese knockoffs are a million times better than the brand name cube. I highly recommend getting a [\\$3 Guanlong](#) or a [\\$9 Thunderclap V1](#) instead of a \$10 brand name cube. These cubes turn much better and can easily knock 30 seconds off your solve times.

For the rest of this tutorial I will assume your cube has the standard coloring of yellow opposite white, green opposite blue, and red opposite orange with a green orange white corner and a yellow red blue corner.

**Note:** This tutorial uses animated gifs. Animations can be played by clicking on figures with arrows underneath. This feature is only supported in Adobe Reader.



## Parts of a cube

While a cube does have 54 stickers it has only 26 "cubies", six of which never even move. A cubie is a single mini cube that makes up the larger 3x3. Each cubie is either a center, corner or edge piece. A center piece has only a single sticker these pieces never move; the white center is always opposite from the white side and can never be next to it. A corner piece has three stickers. Each of the corners makes one of the 8 points of the cube. An edge piece has two stickers and is between two corners and two centers. See Figure 1 for a breakdown of the cube.

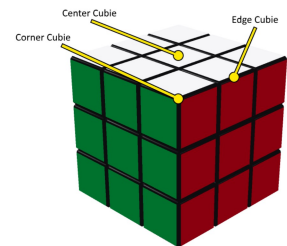


Figure 1

## Cubing Notation

Cubing turn notation is based on how you are holding the cube. A letter is used for a clockwise rotation of each face: Front, Back, Up, Down, Right, and Left. A letter followed by a quotation mark (') means a counter clockwise rotation and a letter followed by a 2 means to do it twice. See Figure 2.

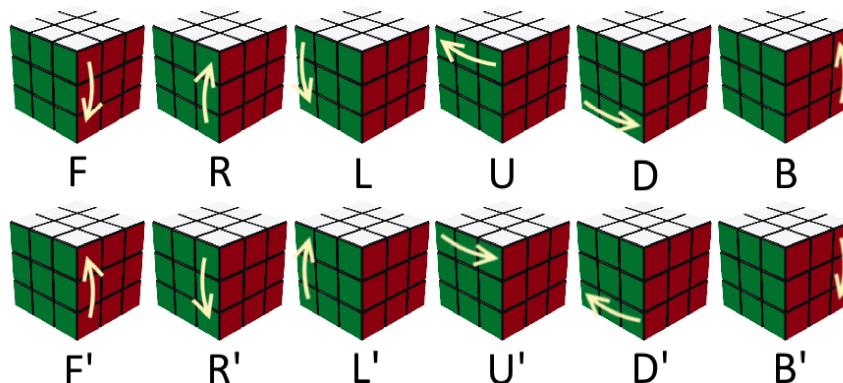


Figure 2

## Steps

We will be solving layer by layer. In the first layer we will solve the white cross then the white corners. In the second layer we will insert four edges into place. Then in the last layer we will put the yellow cross in place, permute the yellow edges, permute the yellow corners, and finally orient the yellow corners. If at any point the cube gets messed up you can always restart.

## First Layer

We will start with the white center on top. The first few steps build the white cross as shown in Figure 3. Then we will put in the white corners, completing the first layer. Don't forget, we aren't solving just the white stickers. We are solving the white cubies. The colors on the side matter.



Figure 3

**Note:** For all examples on the first layer the Front (F) of the cube is green.

1. Scramble your cube.
2. Look for any white edge pieces in the bottom layer. If the white sticker is down rotate the bottom layer (D) until the color lines up with it's center piece. Rotate the face (F) twice. See Figure 4 for an example.
3. Look for any white edges in the middle layer. Rotate the side that the edge is in so that the white sticker moves downward, then repeat step 1. See Figure 5.
4. If a piece is in the top layer, but is backwards hold the cube so that the edge is in the right top face. Perform the moves  $R' F D F' R^2$ . See Figure 6.
5. If you don't have the white cross yet, repeat steps 2-4 until you do.

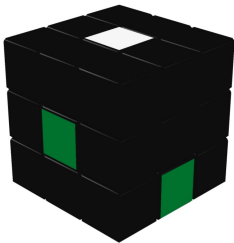


Figure 4

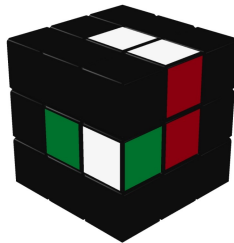


Figure 5

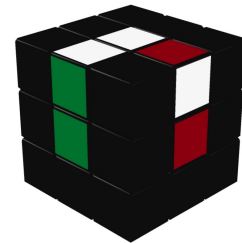


Figure 6

6. Locate a white corner cubie.
7. Use the D movement to position it under the location where it goes.
8. Rotate the cube so that the corner cubie is in the down front right position.
9. Perform the moves  $R' D' R D$  repeatedly until the corner is in the correct position and oriented correctly. See Figure 7.

**Note:**  $R U R' U'$  is called the Sexy Move and it is used everywhere. This is one of it's variants.

- Repeat steps 6-9 for the remaining corner pieces. You have completed the first layer. Your cube should look something like Figure 8.



Figure 7

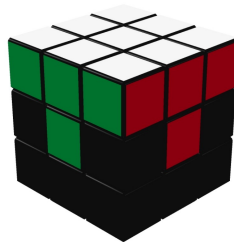


Figure 8

## Second Layer

Because there are only eight cubies on the second layer, with four of them being centers, the second layer will be relatively quick. There are only two algorithms to perform with one of them just being a mirror of the other. When we finish with this layer your cube should look like Figure 9.



Figure 9

**Note:** For all examples on the second layer the Front (F) of the cube is red.

- Hold the cube so that the white face is on bottom and the yellow center is on top.
- locate an edge piece that does not have a yellow sticker. In Figure 10 and 11 I use a green/red cubie.
- Perform Up (U) turns until the color on the side of the cubie matches its center.
- Hold the cube so that the center you matched the cubie with is facing you with the yellow center on top.
- If the top sticker on the cubie matches the color of the face on the right go to (a) otherwise go to (b).
  - Perform the move  $U R U' R' U' F' U F$ . See Figure 10.
  - Perform the move  $U' L' U L U F U' F'$ . See Figure 11.

**Note:** If a piece is already in the second layer, but is oriented backwards use one of the above moves to replace the piece with a another one then put it back starting at step 12.

- Repeat steps 11-14 until the second layer is complete. You are now ready to work on the last layer.



Figure 10



Figure 11

## Last Layer

This is the most complicated of the sections. First we will build the yellow cross, then we will put the cross pieces into the correct spot, then we will put the yellow corners into the correct location, and finally we will orient the corners to complete the cube.



Figure 12

Note: For all examples on the last layer the Front (F) of the cube is red.

## Yellow Cross

Note: All of the Yellow Cross algorithms are the same. The only thing that matters is what pattern the top is in.

16. Hold the cube so the they yellow center is on top.
  - (a) If the only yellow sticker on top is the center go to step 17.
  - (b) If the yellow stickers on top form a short L shape go to step 18.
  - (c) If the yellow stickers on top form a straight line go to step 20.
  - (d) If you already have the cross on top, congratulations. Go to Yellow Edges.
17. Perform the algorithm  $F R U R' U' F'$ . See Figure 13.
18. Hold the cube so that one part of the L is pointing towards you and the other is pointing towards your right.
19. Perform the algorithm  $F R U R' U' F'$ . See Figure 14.
20. Hold the cube so that the straight line is pointing towards your left and right.
21. Perform the algorithm  $F R U R' U' F'$ . See Figure 15.
22. You should now have the yellow cross complete. If you don't play around with the previous steps until you do.



Figure 13



Figure 14

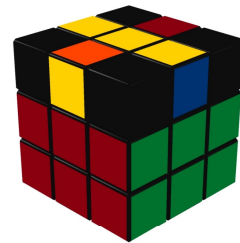


Figure 15



## Yellow Edges

We will be solving the colors on the yellow cross now. **Note:** In figure 16 the orange and green pieces are in their correct place, but the red and blue are not.

23. Perform U moves until 2 or more colors on the cross line up with their centers. If all four colors line up go to Permute Yellow Corners.
24. Hold the cube so that one of the colors that matches points away from you and the other is on your right. If you can't skip to the next step.
25. Perform the algorithm  $R\ U\ R'\ U\ R\ U^2\ R'\ U$ . See Figure 16.
26. If your colors don't match correctly go back to step 23.

## Permute Yellow Corners

We will solve the yellow corners in much the same way as the edges. There is only one algorithm and it will cycle the positions of three of the corners.

27. Examine the cube, find a corner that is in the correct position. If you can't find one pick a corner and continue. **Note:** In Figure 17 The correct corner is the Red/Green corner. All other corners are in the wrong spot.
28. Hold the cube so that the selected corner is in the front right position.
29. Perform the algorithm  $R\ U\ R'\ U\ R\ U^2\ R'\ U$ . See Figure 17.
30. Perform U moves until the yellow edges match up again.
31. If your corners don't match correctly go back to step 27. You shouldn't have to do this more than three times if everything went correctly.



Figure 16

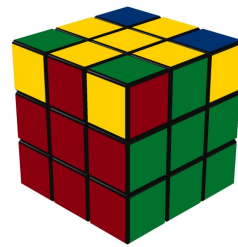


Figure 17

## Orient Yellow Corners

This is the final step in solving your cube. All the pieces are in the correct spot. We just have to rotate the corners. **This step is easy to mess up if you don't follow the algorithm completely. This will result in you having to start over at step 1. Watch Figure 18 before continuing to get a feel for this process.**

32. Hold the cube so that one color is facing you. That center should always face you while you do the algorithm.  
**Warning: Don't forget the last D move in the next algorithm. You will have to restart if you forget.**
33. Perform the algorithm  $R' D' R D$  repeatedly until the corner in the front right position has its yellow side facing up. **Note: The bottom part of the cube will get messed up. That's normal and will be fixed soon.**
34. Perform U moves until the next twisted corner is in the front right position. Repeat steps 32-33 until the cube is solved. See Figure 18 for the full corner solve.

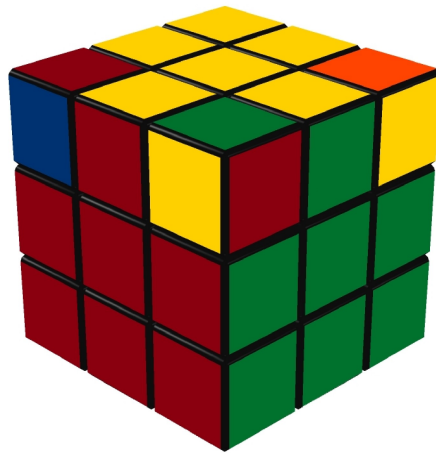


Figure 18

## Conclusion

You have now solved a Rubik's Cube! If you would like to get into speed cubing practice this method until you can solve the cube in less than a minute. The easiest and most popular speed cubing method to learn after this is Fridrich Method AKA CFOP. This method combines the first and second layers into one step and the last layer into two steps. Have fun cubing!!