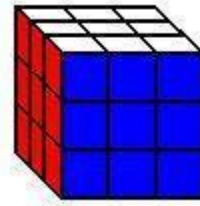


Rubik's Cube: the one-minute solution

***Abstract.** This paper will teach the reader a quick, easy to learn method for solving Rubik's Cube. The reader will learn simple combinations that will place each cube in the desired location. The reader will learn when to use each combination. The drawings and diagrams can be used as a reference when solving Rubik's Cube. After learning the combinations and patterns, the reader will be able to solve Rubik's Cube in one minute or less- every time. Rubik's Cube will be demystified and the 'cube-solver wannabe' can finally be satisfied with solving this addictive puzzle.*



Introducing the Cube

Rubik's Cube is an amazing multi-dimensional puzzle that contains over 43 Quintillion combinations and only one solution. Since its introduction in the early 1980s, over 250 million people have twisted Rubik's Cube in an attempt to solve this addictive puzzle. It is easy to mix the colors, but putting them back is a different story. Using this guide, anyone can easily solve Rubik's Cube and have plenty of fun along the way.

The cube contains six faces, each with a different color. The faces are called top, bottom, sides, front, and back. The front is the side that faces you, while the back is pointed away from you. In the drawing above, blue is the front and white is the top.

Rubik's Cube consists of three vertical columns and three horizontal layers. Each layer and column can be twisted individually. The cube is made up of twenty-six smaller cubes. The center cube on each face stays in place. Corner cubes have three colors, while edge cubes have two colors.

Cube Basics

The easiest way to solve Rubik's Cube is to solve one layer at a time while focusing on only one small cube at a time. The combinations must be performed in the order given. For example, do not try to keep cubes in their correct position on the bottom layer while solving the top layer. You will first solve the top layer, then the middle layer, and then the bottom layer. Always perform combinations while holding the cube in the same orientation. In other words, the top will always be the top. Opposing colors never appear on the same edge or corner cube.

Twisting and cube notation

Quarter Twist

A quarter twist is when a layer is twisted to line up with the side on its right, left, top, or bottom. The quarter twist is indicated by a single arrow pointing in the direction of the twist. For example:

Top →

Half Twist

A half twist is when a layer is twisted to line up with its opposing side. Speed can be gained by twisting the half twist in one fluid motion rather than two quarter twists. The half twist is indicated by two arrows pointing in the direction of the twist. For example:

Bottom →→

Clockwise

A clockwise twist is when a row or column is turned in a clockwise direction. The clockwise twist is indicated by a single arrow pointing in the direction of the twist.

Top → or Right ↑

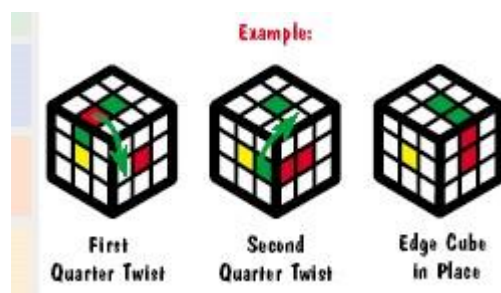
Counter Clockwise

A counter-clockwise twist is when a row or column is turned in a counter clockwise direction. The counter clockwise twist is indicated by a single arrow pointing in the direction of the twist.

Top ← or Right ↓

Positioning cubes

In order to solve the cube, you must twist the rows and columns to place individual cubes where you want them without disturbing the solved layers. This is accomplished by using combinations that have been designed for this purpose. Here is an example from Rubik's *Solutions Hints Booklet* (nd, p. 8):



Combinations and Mirrors

Combinations are a series of twists that will move the cubes into desired locations. Mirrors are the combination done in exact opposite. Note: mirrors are not the reverse of a combination. They are the equivalent of performing the combination as it would appear if you were looking in a mirror.

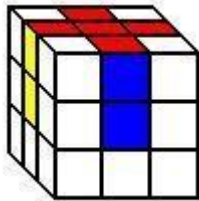
Top Layer

When solving the top layer, every color of each top-layer cube must be placed in the correct position. This means that you must solve not only the top-color of each cube, but also the side-color of each cube. Each side-color must match the center cube of the side that it is positioned. Remember: there is only one edge-cube that contains both red and green stickers. This rule applies to each color.

Note: Colors in these diagrams are for demonstration only. Start with your favorite color or have a friend choose a color for you!

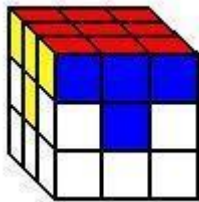
Top Edges

First, using the method in the Rubik's example above, solve the top-edges. This will make a plus sign.



Top Corners

Next, use the same twisting principles to solve the top-corners. Be careful not to affect the top-edges.

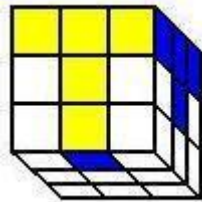


Middle Layer

Look at the bottom-layer to find a cube to be placed. If there is not a middle-edge cube on the bottom-layer, perform the middle-layer combination to free a middle-layer cube. Place the needed middle-layer cube so that it lines up with the center-color. For example, if you are going

to place a blue and yellow cube in its proper place in the middle-layer, and the yellow color is the color that can be placed on the front-face, then align the yellow and blue cube so that the yellow on the middle-cube is touching the yellow on the center-cube. Yellow is now the front-face; the color that is facing you. If blue is the color that is on the bottom-layer face, then you would align blue to blue and perform this combination in mirror. Blue will then be the front-face.

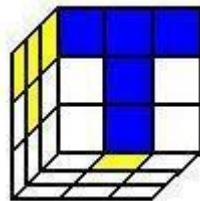
Edge Mover:



Yellow is the front-face

Bottom ← Right ↓ Bottom → Right ↑
 Bottom → Face → Bottom ← Face ←

Edge Mover Mirror:



Blue is the front-face

Bottom → Left ↓ Bottom ← Left ↑
 Bottom ← Face ← Bottom → Face →

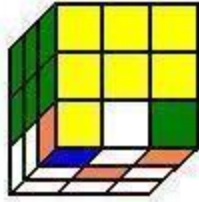
Bottom Layer

Bottom Corners

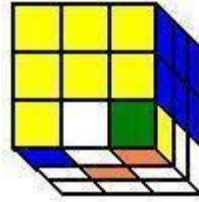
Corner Placement

The corners must first be placed into their correct position. Do not worry about their orientation yet; at this point you are only concerned with placement. Twist the bottom-layer so that the greatest number of cubes is in their correct position. If two or more cubes are opposing their correct corner, you will need to swap them. You may need to do this twice. Place the two corners that need to be swapped on the front-face and perform this combination:

Corner Swap



Yellow is the front-face



Right view

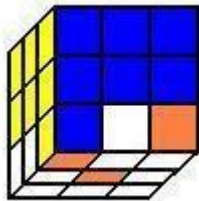
Right ↓ Bottom ← Right ↑ Front →
 Bottom → Front ← Right ↓ Bottom →
 Right ↑ Bottom →→

Perform this combination until all corner-cubes are in their proper places. Do not worry about their orientation at this point.

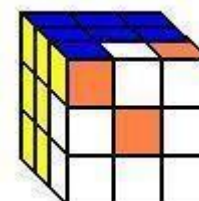
Corner Orientation

Now that you have all of the bottom-corner cubes in their proper position, you can start working on their orientation. First, check to see if you have any cubes oriented correctly. Look at the bottom-face to determine your patterns. You want one, and only one, cube in the correct orientation. This is because the **Three Corner Shuffle** shuffles only three cubes while leaving one in place. Place the cube that is correctly oriented in the top-left corner while looking at the bottom-face. This combination will take the top-right color that is on the front-face and place it on the bottom-face:

Three Corner Shuffle



Blue is the front-face

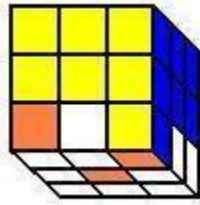


Bottom view

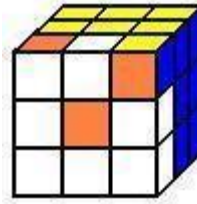
Right ↓ Bottom ← Right ↑ Bottom ←
 Right ↓ Bottom →→ Right ↑
 Bottom →→

If the cube on the right is not the bottom-face color, then turn the whole cube so that the solved bottom-corner cube is on the right side of the front-face. If the left corner-cube is the bottom-face color, perform this combination:

Three Corner Shuffle Mirror



Yellow is the front-face

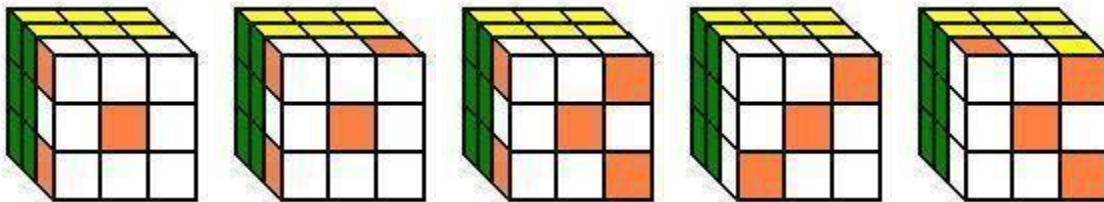


Bottom view

Left ↓ Bottom → Left ↑ Bottom →
 Left ↓ Bottom →→ Left ↑
 Bottom →→

Other Corner Orientation Patterns

If you do not have a corner that is correctly oriented, then look at the bottom-face for one of these patterns and perform the **Three Corner Shuffle** (Note: orange demonstrates the bottom-face. Yellow is used to demonstrate the front-face. The actual color of the front-face may vary.):

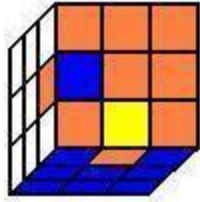


Perform the **Three Corner Shuffle** until you get one of the two desired patterns in the section above.

Bottom Edges

Check the bottom-edges to see if any bottom-edge cubes are placed correctly. Next, look at the bottom-edge patterns to determine which combination you need to perform. If no cubes are correctly placed, choose a combination that will correctly place at least one bottom-edge cube to obtain a solved front-face. The bottom edge 1 and 2 combinations focus on the cube on the bottom left side. The mirrors focus on the cube on the bottom right side. This will help you in deciding which combination to use.

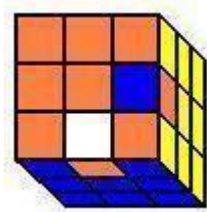
Bottom Edge 1



Bottom view (Blue represents the back-face)

Left ↑	Right ↑	Front ←	Left ↓
Right ↓	Bottom →→	Left ↑	Right ↑
Front ←	Left ↓	Right ↓	

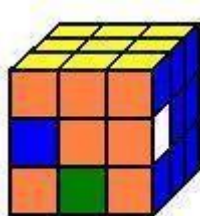
Bottom Edge 1 Mirror



Bottom view (Blue represents the back-face)

Left ↑	Right ↑	Front →	Left ↓
Right ↓	Bottom →→	Left ↑	Right ↑
Front →	Left ↓	Right ↓	

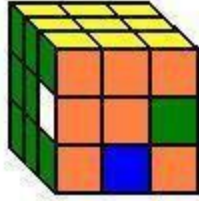
Bottom Edge 2



Bottom view (Yellow represents the front-face)

Front →	Left ↓	Back →	Left ↑
Back ←	Front ←	Bottom →	Back ←
Bottom ←	Back →		

Bottom Edge 2 Mirror



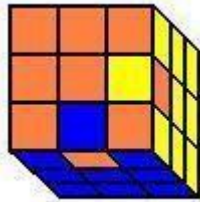
Bottom view (Yellow represents the front-face)

Front ← Right ↓ Back ← Right ↑
 Back → Front → Bottom ← Back →
 Bottom → Back ←

Other Bottom Edge Patterns

Here are the other common bottom-edge patterns that you will see. Select your pattern and perform the combinations listed. Keep the same front-face throughout the series of combinations. If you do not have one of these patterns, look at the bottom-cubes on the right and left sides to decide which cube to place. Choose a combination that will get you one of the common patterns.

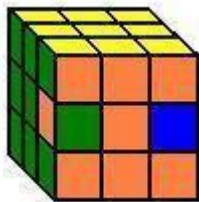
Bottom Edge Pattern 1



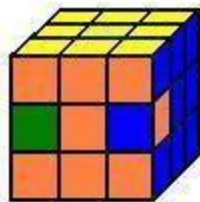
Bottom view (Blue represents the back-face.)

For this pattern, perform a **Bottom Edge 1** followed by a **Bottom Edge 2** combination. Be sure to keep the same front-face throughout the series of combinations.

Bottom Edge Pattern 2



Bottom view, left side (Yellow represents the front-face)



Bottom view, right side (yellow represents the front-face)

For this pattern, perform a **Bottom Edge 2** followed by a **Bottom Edge 1** combination. Be sure to keep the same front-face throughout the series of combinations.

Conclusion

It will take some practice to learn all of the combinations and color patterns. Watch each combination closely as you learn them to see what effect they have in orienting the cubes. This will help you to understand what each combination does, which will help you to decide which combination to use. It is not possible to include every pattern, so learning what each combination is doing would be invaluable. Making quick decisions is important to building speed.

Once you have learned the combinations and patterns, Rubik's Cube can consistently be solved in one minute or less. I average less than one minute with my fastest time being somewhere between 30 and 40 seconds (not counting the times I got lucky). Good luck. Once you have solved your cube and bragged to your friends, mix it up and do it again!

Recommendations

Resources, including Rubik's Cube theory and mathematics:

- a. www.rubiks.com
- b. <http://www.math.ucf.edu/~reid/Rubik/>

Other simple Rubik's Cube solutions and facts:

- a. <http://jjorg.chem.unc.edu/personal/monroe/cube/rubik.html>
- b. <http://jeays.net/rubiks.htm>
- c. <http://www.olympus.net/personal/prnhem/default.htm>
- d. <http://www.beust.com/rubik/>

Solving Rubik's Cube for speed

The official Rubik's Cube speed record is around 16 seconds. This method, known as speed-cubing, requires learning nearly sixty combinations. Speed-cubing is the method used in competition:

a. <http://www.speedcubing.com/>

b. <http://lar5.com/cube/>

Glossary

Clockwise – A turning motion which turns a layer or column in the direction of the moving hands of an analog clock.

Column – A vertical row of cubes.

Combination – A series of predetermined twists with the goal of placing a cube in a specific location.

Counter Clockwise - A turning motion which turns a layer or column in the opposite direction of the moving hands of an analog clock.

Half Twist – Twisting a layer or column so that it lines up with its opposing side.

Layer – A horizontal row of cubes.

Mirror – A combination performed as the opposite of a combination.

Quarter Twist – Twisting a layer or column so that it lines up with the side on its right or left (or top or bottom).

Speed-Cubing – A method of solving Rubik's Cube by using complex combinations that are specifically designed for speed. This is the method used in competition and requires learning around 60 combinations.

Twist – A twist is when a layer or column is turned in a clockwise or counter clockwise direction.

Drawings were created using Microsoft Paint

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