

# Rubik's Cube

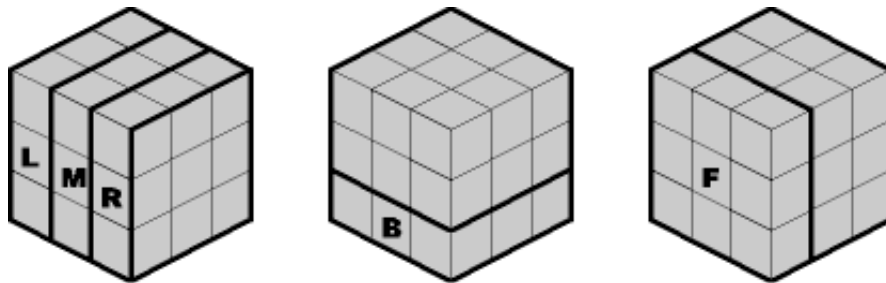


**NOTE:** The center squares on each face of the Rubik's Cube are attached to a crossbar that fixes them in place. They can always rotate in place, but they can never jump from face to face. Therefore, the center square defines what color that entire side will eventually become. **Once you choose what color you want on top, that side will remain as the top side for the entire solution.**

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## Notation:

There are nine layers in a Rubik's Cube, but we only need to concern ourselves with only **five** of them; the three vertical slices (**L**eft, **M**iddle and **R**ight), the **B**ottom layer and the **F**ront side.



- **L+** ...move the LEFT slice UP (1/4 turn)
- **L-** ...move the LEFT slice DOWN (1/4 turn)
  
- **M+** ...move the MIDDLE slice UP (1/4 turn)
- **M-** ...move the MIDDLE slice DOWN (1/4 turn)
  
- **R+** ...move the RIGHT slice UP (1/4 turn)
- **R-** ...move the RIGHT slice DOWN (1/4 turn)
  
- **B+** ...move the BOTTOM layer RIGHT (1/4 turn)
- **B2** ...move the BOTTOM layer HALF-WAY AROUND (1/2 turn)
- **B-** ...move the BOTTOM layer LEFT (1/4 turn)
  
- **F+** ...move the FRONT side CLOCKWISE (1/4 turn)
- **F2** ...move the FRONT side HALF-WAY AROUND (1/2 turn)
- **F-** ...move the FRONT side COUNTER-CLOCKWISE (1/4 turn)

NEXT: Start by solving the [Top Edges...](#)

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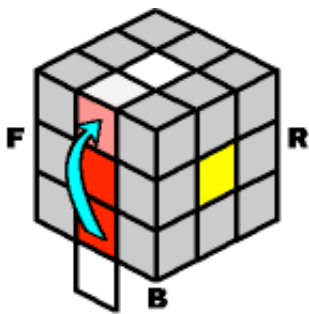
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# Rubik's Cube

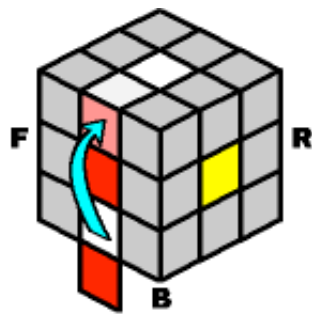
## I. Solve the Top Edges

The cube is scrambled and you are ready to make your very first move to solve it. There are 4 edges that have to be placed on the top layer, one at a time. If the edge is on the bottom layer, then rotate the bottom layer until that edge appears in the front, directly below its destination. The edge can be flipped around two different ways, so there are two different moves used to climb it to the top.

### ~~~~Move Up:~~~~



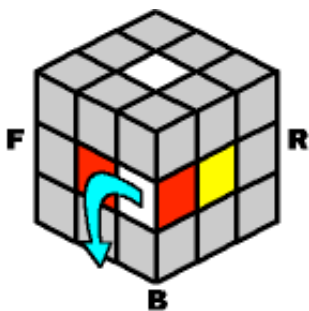
**F2**



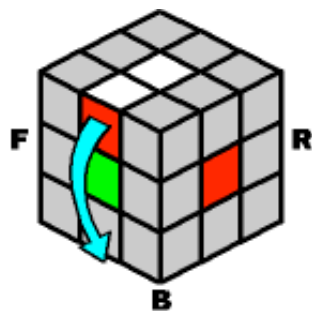
**B+ R+ F- R-**

The edge you want to move may not always be on the bottom layer. Sometimes, it can appear at the "equator" of the puzzle. Other times, it can already be on the top layer, but on the wrong side. Either way, it must be knocked down to the bottom layer. Afterwards, you can climb it up to its correct spot by using one of the previous sequences.

### ~~~~Knock Down:~~~~



**R- B- R+**



**F2**

And finally, you may need to invert an edge that is already in place.

~~~~~**Invert:**~~~~~



**F2 B+ R+ F- R-**

Don't worry, be happy! As you MOVE UP, KNOCK-DOWN or INVERT an edge, the other edges that you've already finished will NOT be disturbed in ANY way, by ANY of these moves.

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After arranging all 4 top edges, continue to solve the [Top Corners](#).

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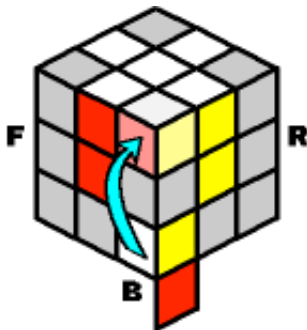
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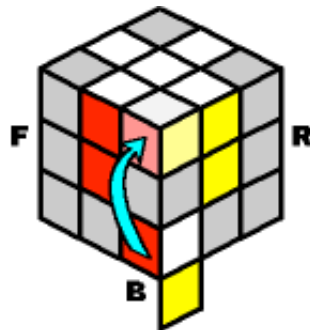
## II. Solve the Top Corners

Below are 3 ways to get a corner piece from the bottom to the top. Because a corner can be rotated 3 different ways, there are 3 different sequences to get the corner piece arranged correctly. Before attempting any of these moves, you must rotate the bottom layer until the desired corner piece is directly below its destination.

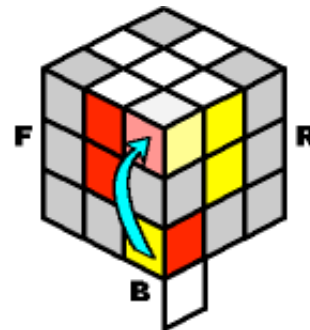
### ~~~~Move Up:~~~~



**F+ B+ F-**



**R- B- R+**

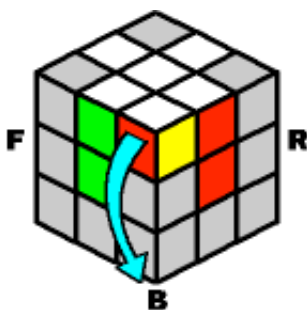


**R- B2 R+ B+  
R- B- R+**

*Oops! Did you MOVE UP this corner piece the wrong way? Don't panic... you can either KNOCK DOWN this piece, and start it over again; or merely ROTATE that same piece in its place later on.*

Sometimes, a corner piece is already in the top layer, but on the wrong corner. Use the simple sequence below to knock it down to the bottom layer. Afterwards, you can climb it up to its correct spot by using one of the previous sequences.

### ~~~~Knock Down:~~~~



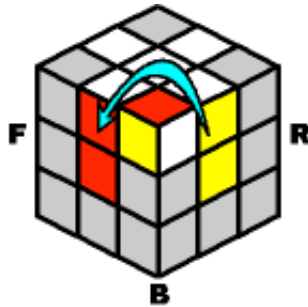
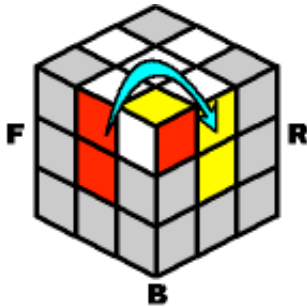
**R- B- R+**

Other times, a top corner piece is in the right spot, but rotated wrong. So...

~~~~~**Rotate**~~~~~

**Clockwise:**

**Counter-Clockwise:**



**R- B+ R+**  
**F+ B+ F-**

**F+ B- F-**  
**R- B- R+**

You only need to memorize **one** of the above. For example, if you choose to memorize the "clockwise" sequence, then use it **twice** to rotate a corner piece counter-clockwise.

Go ahead and solve the other top corners. You will not disturb any of the others that are already fixed in place. After arranging all 4 top corner-cubes... Congratulations! The entire top side is finished, which is enough to amaze anyone. Now you can proceed to solve the [Middle Edges](#)

...or you can SCRAMBLE the puzzle again, and re-solve the Top Layer. WHAT? Are you CRAZY?? NOOO!!! By re-solving the top layer, you become more accustomed with the Rubik's Cube and the moves that solve it. It also builds up an arsenal of ammunition that conquer the later steps.

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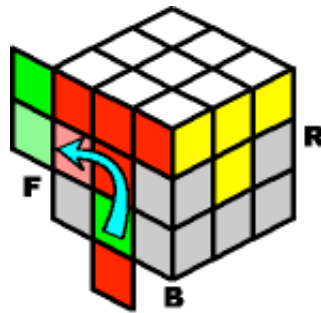
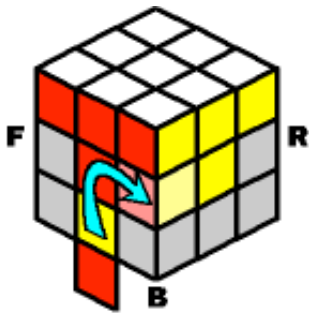
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# Rubik's Cube

## III. Solve the Middle Edges

Chances are, you have edges on the bottom layer that need to be moved up to the equator. Rotate the bottom layer to set the edge piece in the starting position. Before doing any moves, you must make sure that the patterns are just like the diagrams below. The colors may be different, but the pattern must be the same. Notice how the edge piece (on the bottom, in the *starting* position) looks like it's mismatched with the front side.

### ~~~~Move Up:~~~~



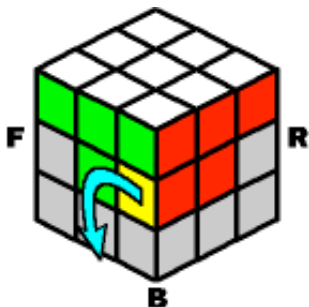
**B2 M- B- R-  
B+ M+ B- R+**

**B2 M- B+ L-  
B- M+ B+ L+**

It may be scary at first. When solving the middle edges, the top side gets scrambled temporarily; but after the 8 moves are over with the top side is intact again.

A middle-edge piece could already be in the equator, but in the wrong spot. Use the sequence below to knock it down to the bottom layer. You can move it back to its proper place later, by using one the sequences above.

### ~~~~Knock Down:~~~~



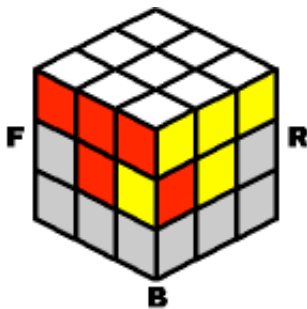
**M- B- R- B+  
M+ B- R+**

In case you haven't noticed, this sequence looks very similar to one of the "move-up" sequences. In reality, all you are doing is moving up an edge from the bottom, which in turn knocks down the target edge from the equator.

*Hint: Use the "Knock-Down" sequence only as a LAST RESORT. Almost all the time, that edge can be knocked down to the bottom layer later anyway, when you are merely doing a "Move-Up" sequence with another middle-edge piece.*

A middle-edge piece could already be in the equator and at the right spot, but inverted. Use this move to flip it around:

~~~~~**Invert:**~~~~~



**M- B- R- B+**  
**M+ B- R+ B-**  
**M- B- R- B+**  
**M+ B- R+**

The bad news is, at 15 moves that this sequence is very long. The good news is that you don't have to memorize it! This sequence is actually a combination of the "knock-down" sequence, followed by one of the "move-up" sequences. So if you don't want to memorize this, knock down the edge from the equator (by using the "knock-down" sequence), and then turn the bottom layer until that edge appears on the bottom-front. After that, move the edge up using the proper "move-up" sequence.

### A Shortcut for ONLY the Experts:

I know this is an odd-ball move, but I couldn't resist adding it. It **swaps** the two middle-edges on the front side:

**F2 B2 F2 B2 F2**

*If you are a amateur, then IGNORE the shortcut. You can try that some other day once you have mastered the Cube.*

You do NOT need to use the shortcut. The other moves (MOVE UP, KNOCK DOWN and INVERT) are enough to solve each middle edge. After arranging all 4 middle edges, continue to solve the [Bottom Corners](#).



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# Rubik's Cube

## IV. Solve the Bottom Corners

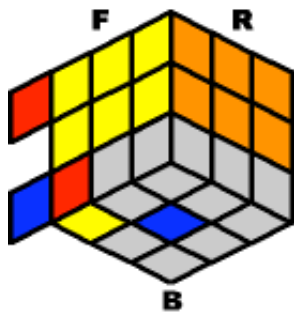
By now, all 4 bottom corners (and 4 bottom edges) are already in the bottom layer, so there are no more "move-up" or "knock-downs" moves anymore. From now on, all moves will either swap pieces around or twist them in their spot. The first step is to arrange the bottom corners in the correct positions:

### ~~~~Place the Bottom Front Corners~~~~

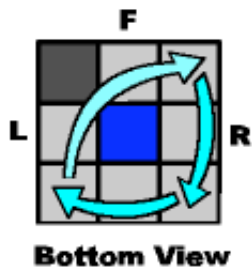
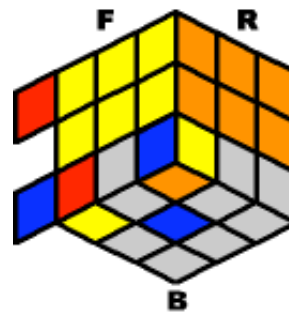
Turn the bottom layer until the lower-left front corner cube is in place

Repeat this sequence:

...until both lower front corners are in place.



**R- B+ L- B-  
R+ B+ L+ B-**



What the move does:  
It swaps the other 3 corner cubes on the bottom layer clockwise.

You may have to repeat the sequence **twice** to fix the front bottom corners in place.

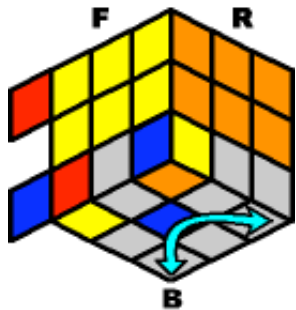
### Variations:

For you experts, there are variations to the prior sequence that yield powerful results. There is no need to memorize any of these, as all the other moves give you enough ammunition to solve the cube. But if you want to save a few moves, here they are:

| Sequence:                         | Result:                                           |
|-----------------------------------|---------------------------------------------------|
| <b>B- R- B+ L- B- R+ B+ L+ B2</b> | The same 3 corners are swapped counter-clockwise. |
| <b>B2 R- B+ L- B- R+ B+ L+</b>    | The (bottom) right 2 corner cubes are swapped.    |
| <b>B+ R- B+ L- B- R+ B+ L+ B+</b> | The (bottom) back 2 corner cubes are swapped.     |

The two front (bottom corner) cubes should now be in place. The back ones may also be in place; but if they are not, **swap** them with the following move:

~~~~~**Swap the Bottom Rear Corners**~~~~~



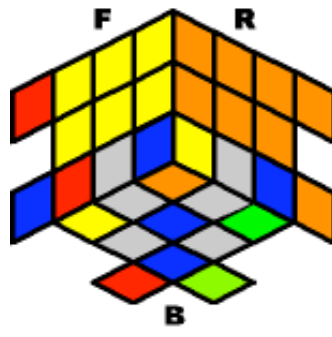
**B+ R- B+ L-  
B- R+ B+ L+  
B+**

You only have to do the sequence **once** to swap the rear bottom corners in place.

All 4 bottom corner cubes are now in place. The next step is to twist each corner so that their bottom sides are the correct color. In the worst-case scenario, **NO** corner cube has a bottom side with the correct color. In this case, do the following move:

~~~~~**Finish (at least) One Corner Cube**~~~~~

**R- B- R+ B-  
R- B2 R+ B2**



You only have to do this **once**. Now there is at least **ONE** corner cube is finished, with the right color on

the bottom side.

*Note: Ignore the diagram. As long as you keep the original top face on the top side, this sequence will guarantee that at least ONE bottom-corner cube will be finished afterwards.*

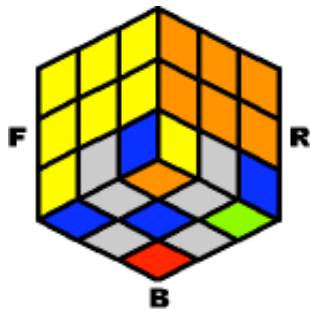
Now it is time to finish another corner cube:

~~~~Finish the Bottom Front Corners~~~~

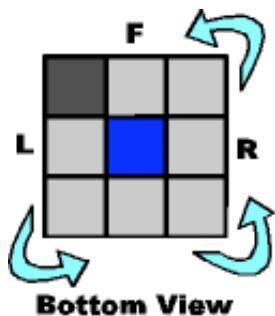
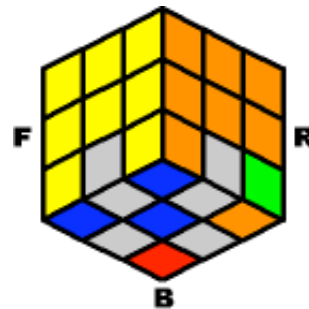
**Rotate the entire puzzle so that (one of) the finished corners is in the lower-left front**

**Repeat the move:**

**...until both front corners are done.**



**R- B- R+ B-  
R- B2 R+ B2**



**What the move does:  
It twists each of the other 3 corner cubes counter-clockwise.**

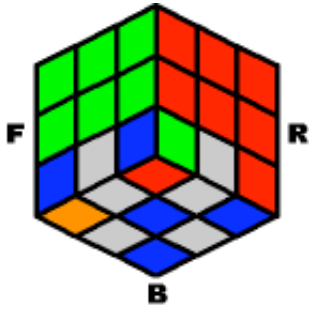
You may have to repeat the sequence **twice** to finish the front bottom corners.

The two front (bottom corner) cubes should now be finished. The back ones may also be done; but if they are not...

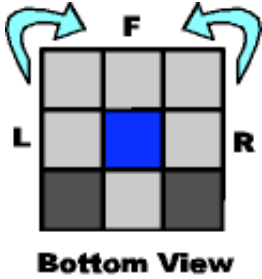
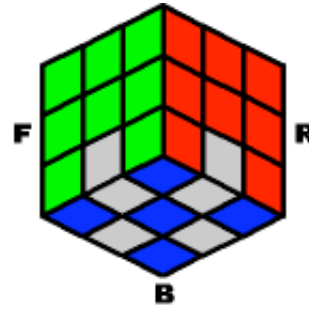
**Rotate the entire puzzle so that the finished corners are in the back**

**Repeat the move:**

**...until all four corners are done.**



**R- B- R+ B-  
 R- B2 R+ B2  
 L- B+ L+ B+  
 L- B2 L+ B2**



**What the move does:  
 It turns one corner  
 clockwise, and turns  
 the other corner cube  
 counter-clockwise.**

You may have to repeat the sequence **twice** to finish all four corners.

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It is now time to solve the [Bottom Edges](#).

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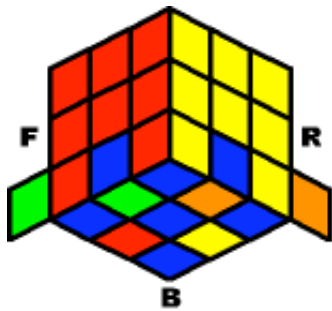
# Rubik's Cube

## V. Solve the Bottom Edges

The end is near. At this point, there are three possibilities:

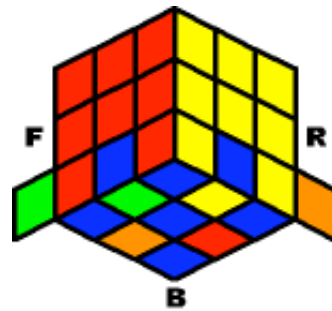
- **NO bottom edge is in place**
- **Only 1 bottom edge is in place**
- **All 4 bottom edges are in place**

If **NO** bottom edge is in place, then use the sequence below:



**Before**

**M- B- M+ B2**  
**M- B- M+**



**After**

You only need to do this sequence **once**.

*Note: Ignore the diagrams. As long as you keep the original top face on the top side, this sequence will guarantee that at least ONE bottom-edge cube will land in place afterwards.*

If only **ONE** bottom edge is in place, then rotate the entire puzzle until the fixed bottom edge piece appears in the front. The remaining 3 bottom edges need to be swapped either clockwise or counter-clockwise.

**Exchange**  
**Clockwise:**

**Exchange**  
**Counter-Clockwise:**



**M- B+ M+ B2**  
**M- B+ M+**

**M- B- M+ B2**  
**M- B- M+**

You only need to memorize **one** of the above. For example, if you choose to memorize the "counter-clockwise" sequence, then use it **twice** to swap the 3 edges clockwise. Once all 4 bottom edges are arranged in place, get ready for the last step: Inversion.

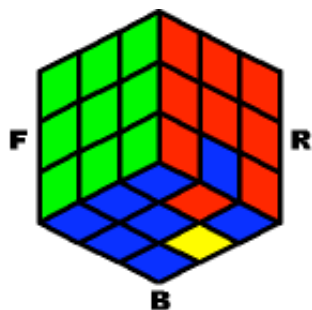
### Inversion

There are 3 different inversion schemes:

1. Invert 2 adjacent edges
2. Invert 2 opposite edges
3. Invert all 4 edges

For each inversion scheme, you must rotate the entire puzzle so that the inverted edges are positioned exactly like the ones in the diagrams, *before* attempting the sequence of moves!

~~~ Case #1: Invert two adjacent edges ~~~



**M- B- M+ B-**  
**M- B2 M+ B2**  
**M- B- M+ B-**  
**M- B2 M+ B2**

**Result:**

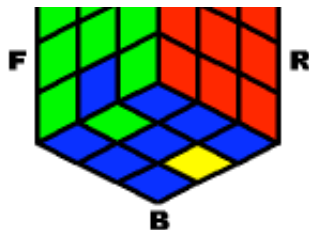
The bottom edges are solved. In fact, the entire puzzle is solved.

~~~ Case #2: Invert two opposite edges ~~~



**M- B- M+ B-**

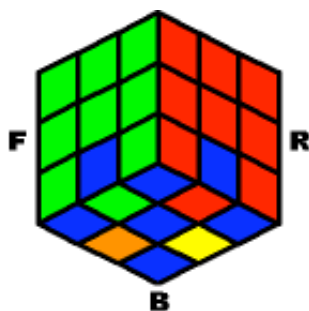
**Result:**



**M- B2 M+ B2**  
**M- B- M+ B-**  
**M- B2 M+ B2**

**Two adjacent edges  
 are still inverted.  
 Go back to Case #1,  
 do the sequence, and the  
 bottom edges are solved.**

~~~ Case #3: Invert all four edges ~~~



**M- B- M+ B-**  
**M- B2 M+ B2**  
**M- B- M+ B-**  
**M- B2 M+ B2**

**Result:**

**Two adjacent edges  
 are still inverted.  
 Go back to Case #1,  
 do the sequence, and the  
 bottom edges are solved.**

As it turns out, the *same sequence* was used throughout *all three cases*. Now that your cube is solved, put it back in the box and return it to the toy store (you still have the receipt, don't you?); take the cash and buy a 6-pack!

**THE END**

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