



The
IDEAL
Solution

Rubik's CUBE™ PUZZLE

an Introduction and Solution

Well, now that you have experienced the challenge of Rubik's Cube and lost, you know why we say it's so diabolical and perplexing. Cheer up! In order to help you regain your sanity, we have developed the following simple approach to the ultimate solution of the Cube. Take heart -

with a little practice and some memorization we will soon have you dazzling your friends, relatives and total strangers with your new found mastery of Rubik's Cube. You can tell them you took a short course in group theory and linear algebra.

The solution to Rubik's Cube requires concentration and faithful attention to the detailed instructions in each Part. It should take you about an hour to read the directions and solve the Cube mechanically. However, if you repeat the process several times, you will begin to understand how and why each group of moves work. You may even develop your own approach to the solution.

We suggest that you memorize the groups of moves so that you learn to solve the Cube without the directions. Once you can solve it on your own, the fun really begins as you try to do it faster and faster. Rubik's Cube can be solved in 2 minutes flat, so have fun!

To solve the Cube, you must first understand all of the component parts of the Cube and master a few basic moves.

1. THE CUBE

Basic Cube Parts - Rubik's Cube is a deceptively innocent looking 2 1/4" cube with over 3 billion possible color combinations. It has 6 sides, 6 colors, and 26 smaller sub-cubes (see figure A). There are 8 corner pieces with 3

colors, 12 middle edge pieces with 2 colors and 6 centers with 1 color each (see figure B). In the ultimate solution, each sub-cube has only one correct location.

There are 26 small sub-cubes that make up a whole cube.

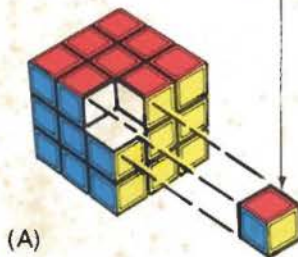
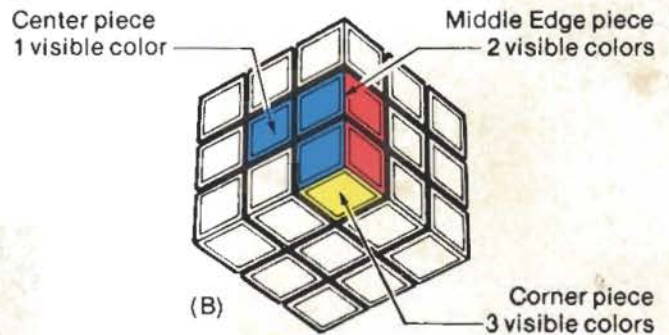


Figure 1

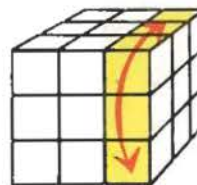
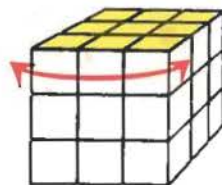


2. PERSPECTIVES

First, to make sure we are looking at the cube in the same way we must agree what to call each side:

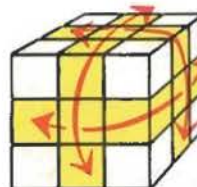
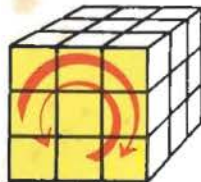
Figure 2

Top can only turn Left or Right



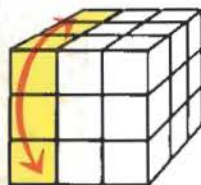
Right can only turn up away or toward you and down.

Front can only turn Clockwise or Counter Clockwise



Center can turn up & away, toward you & down, left & right, and clockwise or counter clockwise. (An easy way to do this is to move the center and the right side up & away together, then move just the right side back down one turn).

Left can only turn up and away or toward you and down



All turns are either 90° (1 turn) or 180° (2 turns).

3. COLOR ALIGNMENT

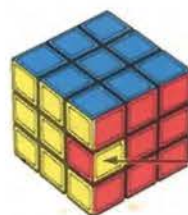
Color Alignment is an important concept to understand, and it is illustrated in figures 3A and 3B. A completed cube (A) has all its pieces color aligned. Now imagine popping

out one sub-cube, then putting it back in with its 2 colors reversed. This piece would now be *in correct position but not color aligned*. (See (B) below).

(A)
Completed cube.
All pieces
color aligned.



Figure 3

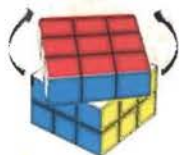


(B)
This piece is in
correct position
but is not color
aligned.

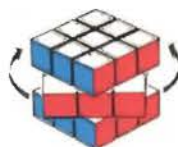
4. HOW IT WORKS

A. The cube can be manipulated by rotating rows vertically or horizontally, and just a few simple turns are required to produce a completely random pattern of color.

Figure 4



a. Horizontal
rotation of
top row

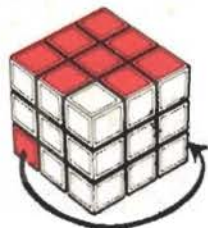


b. Horizontal
rotation of
middle row

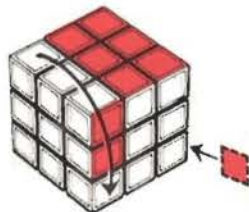


c. Vertical
rotation of
center row

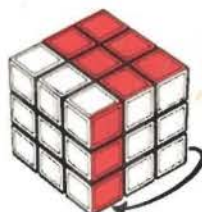
C. In order to solve a side you must move certain cubes from vertical to horizontal planes, to line up rows of 3 sub-cubes of the same color. Note: one turn moves a sub-cube 3 places, and 2 turns will move it 6 places:



1st Move:
Turn bottom to right
2 turns



2nd Move:
Top down
1 turn



3rd Move:
Bring red back by
turning bottom left
1 turn

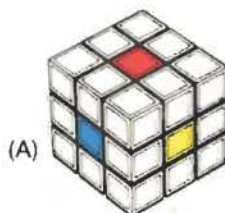


4th Move:
Bring 3 reds
back on top

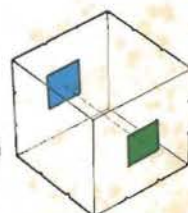
B. a) The center square on each side determines the color of that side (See figure 5A).

b) No matter how the colors are mixed, if you were to hold your thumb and forefinger on opposite center pieces, they would show you which colors appear opposite each other on the cube, e.g., if left center is blue then right center must be green. (See figure 5B).

Figure 5



(A)



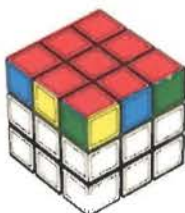
(B)

Note: This may vary from cube to cube since each cube may be labeled differently.

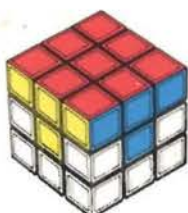
5. THE OBJECT

The object is to return all 6 sides to their original solid colors, and there is lots of satisfying fun along the way as

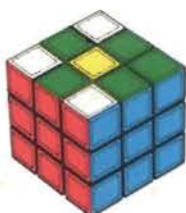
you solve one or more sides to create interesting new patterns of color. Here are the levels of skill you can attain:



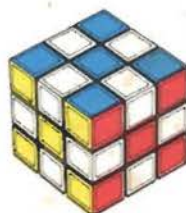
A. Solve one side in
any fashion—
You're a **Star**



B. Solve one side
correctly—
You're an **Expert**



C. Solve two adjacent
sides—
You're a **Master**



D. Solve eight corners
correctly—
You're a **Grand Master**



E. Solve all six sides—
Congratulations
You're a **Cubist!**

THE SOLUTION

We will approach the solution by breaking it down into 5 more manageable parts. These 5 parts must be done in the following order:

PART I SOLVE THE TOP CORRECTLY.

PART II PUT THE BOTTOM 4 CORNERS INTO PLACE.

PART III COLOR ALIGN THE BOTTOM 4 CORNERS

PART IV SOLVE 2 SIDES OF THE CUBE.

PART V POSITION AND COLOR ALIGN ALL REMAINING OUT OF PLACE MIDDLE-EDGE PIECES

PART I SOLVE THE TOP CORRECTLY.

Before you begin to solve Rubik's Cube, you must first learn how to solve one side *correctly*. Ironically, solving the first side is easy to perform but hard to explain because

SOLVING THE BLUE SIDE

Note: Solve for *blue* first so that we will be talking about the same reference color. *The other colors may not match our diagrams since each cube may be labeled differently.*

Part I is divided into three sections:

Section A describes *two* moves that will help you position and color align the *4 blue corners*.

Section B gives you 5 basic maneuvers you will need to bring the *4 blue top middle-edge* pieces up into position

the missing pieces are randomly dispersed over the entire cube.

and color aligned. These five maneuvers don't have to be done in any order. You should learn them and use them as you need them.

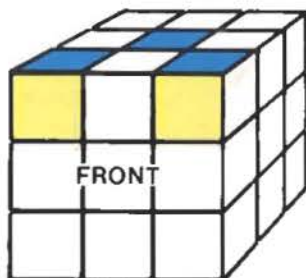
Section C defines the starting position.

A. Position and color align 4 blue corners.

Move the four corner sub-cubes with *blue and the blue center* to the top of the cube so that the blue squares ap-

pear on top. As you bring up the blue corners, try to bring them up into correct color alignment as shown in figure 6.

Figure 6



2 blue corners in correct position. Note matching yellow side edge colors.

If you cannot bring the four blue corners up into correct color alignment, then bring them to the top any way you

can. We will show you how to exchange them so that they fall into correct position and color alignment.

If you bring up the blue corners *in any fashion*, one of 3 things will happen.

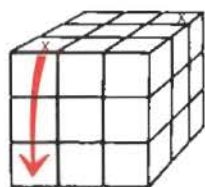
a) *None* of the corners will be in position.

b) *Two* of the corners will be in position & color aligned, or

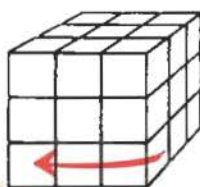
c) *All 4* corners may fall into correct color alignment by accident. In this case, you go on to Section B on page 5.

a. If *none* of the corners are in position, keep the blue reference corners on top, and follow steps 1-9 below.

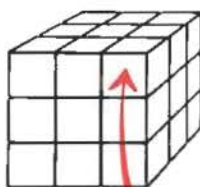
Note: The X'ed corners are the ones that will exchange.



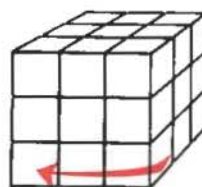
Step 1
Left Side
Down



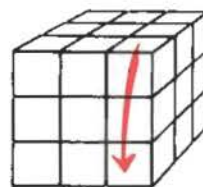
Step 2
Bottom Left



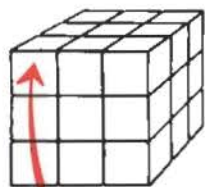
Step 3
Right Side
Up



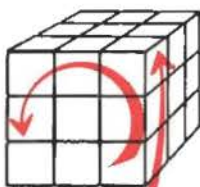
Step 4
Bottom Left



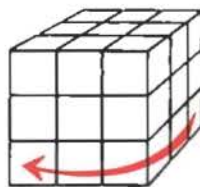
Step 5
Right Side
Down



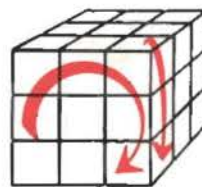
Step 6
Left side
Up



Step 7
Front Counter
Clockwise



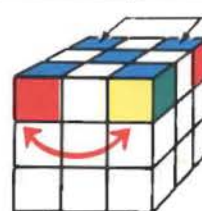
Step 8
Bottom Left
(2 turns)



Step 9
Front Clockwise

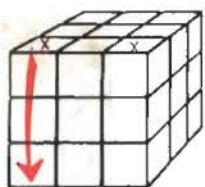
b. If *two* of the blue corners are in position and color aligned, the remaining two *incorrect* blue corners must be exchanged. Keep the blue reference corners on top, and turn the *whole cube* until the two *incorrect* corners face you as shown in figure 7 at right. Now, follow steps 1-10 below.

Figure 7

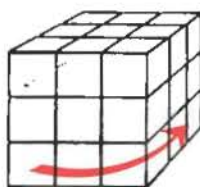


2 correct blue
corners in back

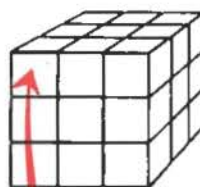
Note: Grasp the non-moving 2 thirds of the cube firmly to maintain your starting orientation (blue on top). The X'ed (incorrect) corners are the ones that will exchange.



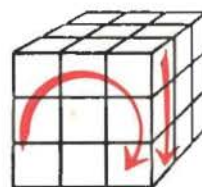
Step 1
Left Side
Down



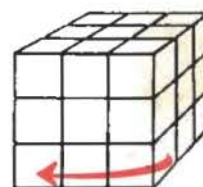
Step 2
Bottom Right
(2 turns)



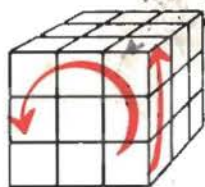
Step 3
Left Side
Up



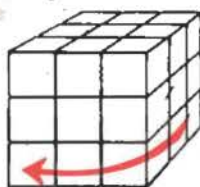
Step 4
Front Clockwise



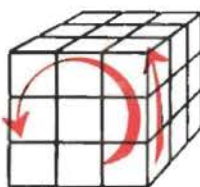
Step 5
Bottom Left



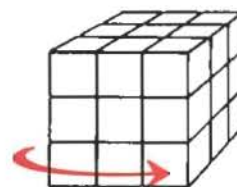
Step 6
Front Counter
Clockwise



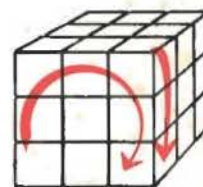
Step 7
Bottom Left
(2 turns)



Step 8
Front Counter
Clockwise



Step 9
Bottom Right



Step 10
Front Clockwise

At this point, you should have 4 blue corners in position and color aligned as shown in figure 8.

Now you must position and color align all 4 top middle-edge pieces.

Note: All 4 pairs of side edge colors must match up.

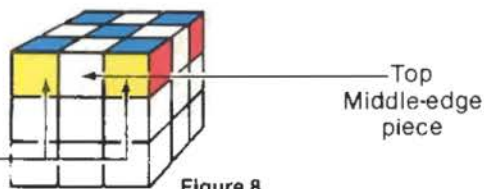


Figure 8

B. Solving the four blue middle-edge pieces.

The correct top middle-edge pieces will be found in one of three places: *on top*, either in position or out of position; *on the middle row* or *on the bottom row*.

a. To bring up a middle-edge piece *from the middle row* as shown in figure 9, read the note below. Then follow steps 1-4 below.

(1) This is an out of place top middle-edge piece on the middle row.

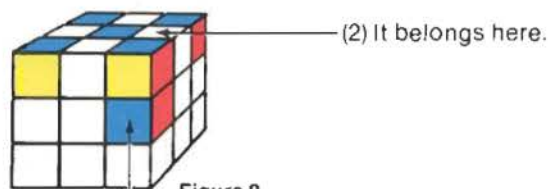
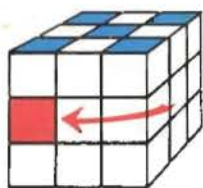


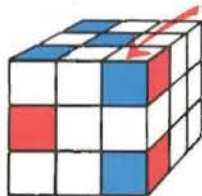
Figure 9

Note: Before you do steps 1-4, keep the *blue* reference color on top, and turn the *whole cube* until an out of place top middle-edge piece appears in position #2 above. Then

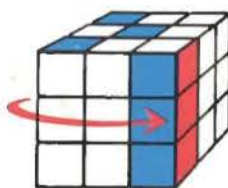
move the middle row horizontally until the piece you need falls into position #1. This is the correct starting position for this process. Now proceed to do steps 1-4.



Step 1
Center Left
(to save it off to the side)

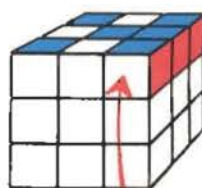


Step 2
Right Side
Down



Step 3
Center Right
(Moves back missing piece in between 2 blues from top).

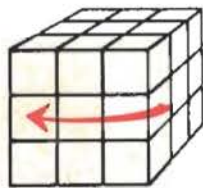
STOP!
See
Note
Below



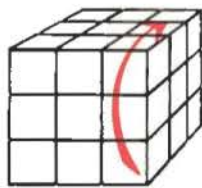
Step 4
Right Side up
(Moves all 3 back on top).

Note: Proceed to step 4 *only* if the missing top middle-edge piece falls into correct color alignment as shown in

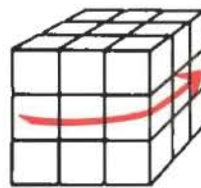
step 3 diagram above. If the piece is *out* of color alignment, proceed to do steps 4A-4D below:



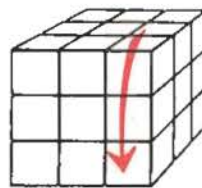
Step 4A
Center Left



Step 4B
Right Side
Up & Away (2 turns)



Step 4C
Center Right
(2 turns)



Step 4D
Right Side
Down

b. To bring up an out of place top middle-edge piece from the *bottom row*, first move the piece you *need* directly below where it belongs as in figure 10, then follow steps 1-4 below:

Red on bottom

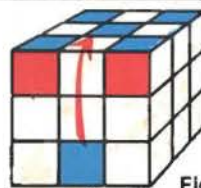
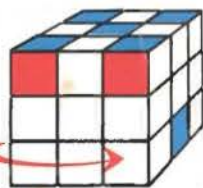
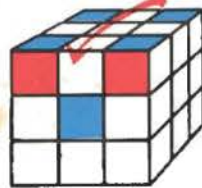


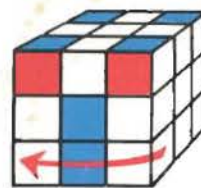
Figure 10



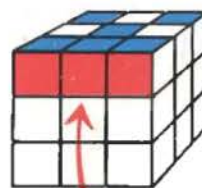
Step 1
Bottom Right
(Saves missing piece on the side)



Step 2
Center Down
(Brings Center piece down)



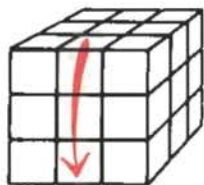
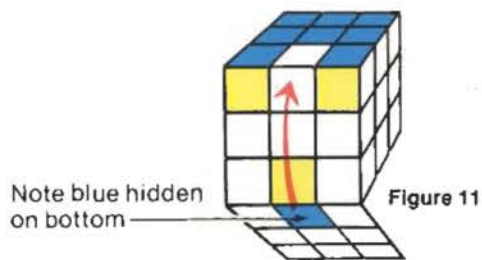
Step 3
Bottom Left
(Moves missing piece under matching center square)



Step 4
Center Up
(Moves missing piece up into place on top)

c. You may find an out of place top middle-edge piece with the blue reference color hidden on the bottom of the cube. Turn *just the bottom row* until this piece is lined up directly

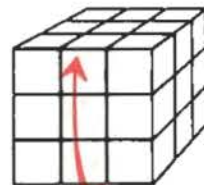
below where it belongs. See figure 11, then follow steps 1-3 below.



Step 1
Center toward
you and down



Step 2
Bottom Left
(2 turns)



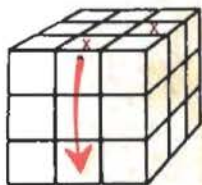
Step 3
Center Up
& Away

d. You will sometimes find top middle-edge pieces that are already on top but must be exchanged in order to fall into correct color alignment. See figure 12.

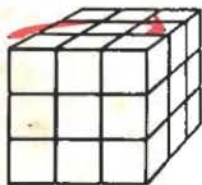


Blue & yellow middle-edge piece must exchange with blue & red piece to be in correct color alignment

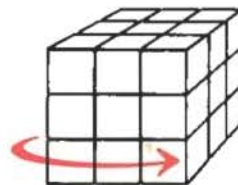
To exchange the two top middle-edge pieces shown in figure 12 follow steps 1-6 below. Note: X'ed pieces are the ones that will be exchanged. *Keep blue on top.*



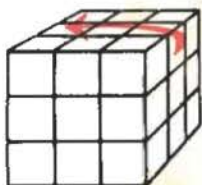
Step 1
Center Down



Step 2
Center Clockwise



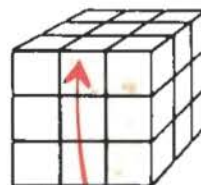
Step 3
Bottom Right



Step 4
Center Counter
Clockwise

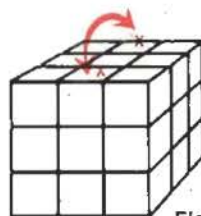


Step 5
Bottom Left
(2 turns)



Step 6
Center Up

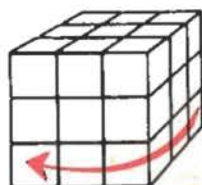
e. To exchange 2 top middle-edge pieces that face each other on top of the cube as shown in figure 13, keep blue on top, and follow steps 1-3 below.



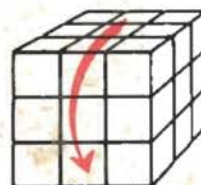
Note: The X'ed pieces will be exchanged



Step 1
Center Up
and Away
(2 turns)



Step 2
Bottom Left
(2 turns)



Step 3
Center Back
and Down
(2 turns)

If you practice solving one side correctly, you should eventually be able to put all 9 pieces of any color into correct

color alignment in less than one minute. The more you practice the less you will have to depend on the diagrams.

C. The starting position defined.

To begin solving the whole puzzle, first solve the **blue** side correctly, but leave one of its middle-edge pieces unsolved. This is known as the **STARTING POSITION**. (See figure 14 at right). The missing piece will act as a guide in Part IV.

Note: Except for the blue reference color, we won't refer to specific colors, since they don't matter, and each cube may be labeled differently.

Now that you have solved one side of the cube correctly, you have actually solved $\frac{1}{3}$ of it. At this point you are in the **STARTING POSITION**, and you are ready to proceed to Part II since you have 4 of the corner sub-cubes in correct position *and* color aligned on the solved side.

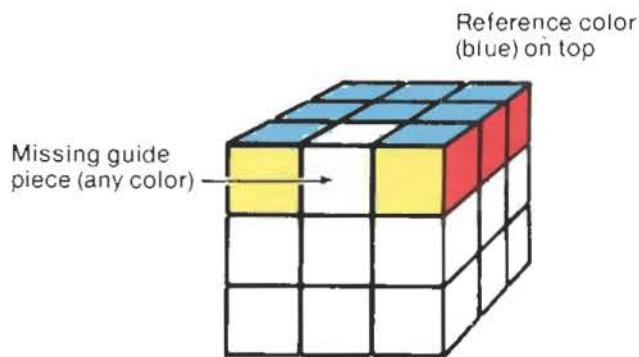


Figure 14

PART II - PUT BOTTOM 4 CORNERS INTO PLACE.

The *object* of this part is to put each of the 4 remaining corner sub-cubes into its proper place (but not color aligned).

A. Hold the completed blue side away from you. This is important. Throughout Parts II and III the completed side must be held *away* from you (at the back of the cube) at all times! See diagram (Figure 15). This next process exchanges Bottom Left Corner (A) with Bottom Right Corner (B).

While holding the completed side away from you, examine the 4 corners of the cube facing you (the front 4 corners, (ABC & D). Check to see if any 2 or all of them are in correct position. **You will always be able to find either 2 or 4 corners in correct position.** If you only find one or you find none, then rotate the front face of the cube and check again.

Keep complete blue side in back.

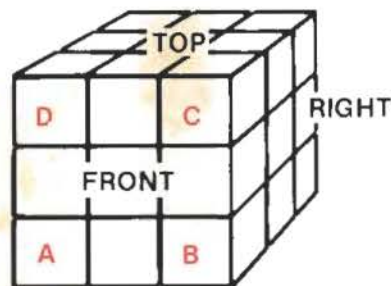
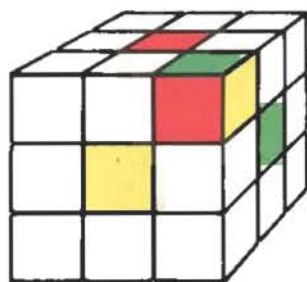


Figure 15

A corner is in correct position only if all 3 of its colors match all 3 of the colors of the center squares it touches as in figure 16A below. Figure 16A shows the top right corner

Figure 16A

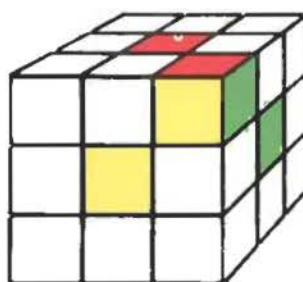


This is an example of a corner in *correct position* but *not color aligned*. Notice the corner is red, green and yellow and the 3 center squares it touches are red, green and yellow.

If you find all 4 front corners in correct position, then go on to Part III. If you find 2 corners in correct position they will either be side by side (in A&B or in D & C) or diagonally across from each other (in A & C or D & B). See figure 15 above.

in position but not color aligned. Figure 16B shows the same corner in position **AND** color aligned.

Figure 16B

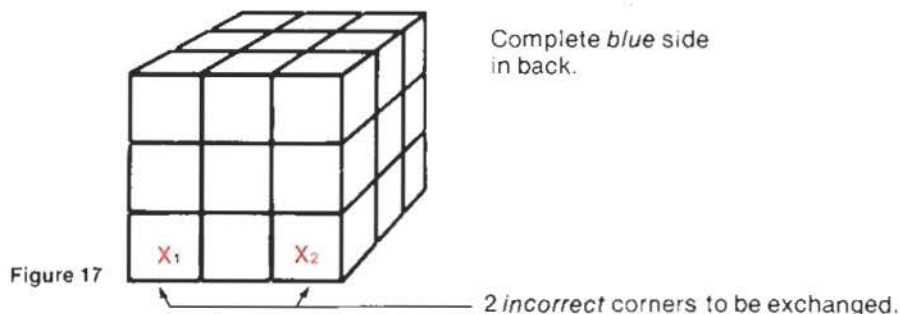


This is an example of the same corner in *correct position* **AND** color aligned. Notice red touches red, green touches green and yellow touches yellow.

Remember, you must always find 2 or 4 of the front corners in correct position. If you find none or only one correct, then keep rotating the front face of the cube and check all 4 front corners after each turn until you find 2 or 4 correct.

B. If the 2 corners in correct position are *next to each other* (in A & B or C & D) then you must exchange the other 2 remaining front corners. To do this, turn the *whole cube*

until the 2 *incorrect* corners appear in the X'ed positions as shown on figure 17. Keep the completed blue side in back and follow steps 1-8 below.

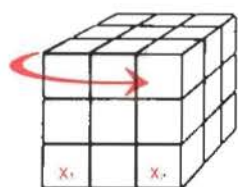


C. If the 2 corners in correct position are *diagonally opposite each other* (in A & C or D & B) then you will have to repeat steps 1-8 twice. Follow steps 1-8, then rotate the *front face* of the cube one turn clockwise or counter clockwise and check the corners again. Now you should find 2 corners *side by side* in correct position. To exchange the remaining 2 out of place front corners, turn the **WHOLE CUBE** until the 2 *incorrect corners* appear in the X'ed positions as shown above in figure 17. Now run steps 1-8 again.

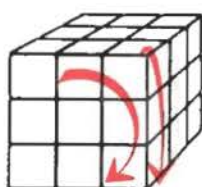
Hint: Get a grease pencil and mark the 2 corners you want to exchange 1 and 2. Then run the process, and you will be able to verify that they changed places.

Grasp the non-rotating two thirds firmly so that the orientation does not change from move to move. After the eighth move, verify that the selected corner sub-cubes exchanged positions and the initially completed blue side is not disturbed.

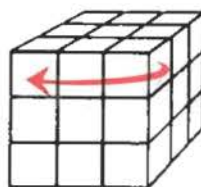
Remember to keep the *completed blue side in back, away from you.*



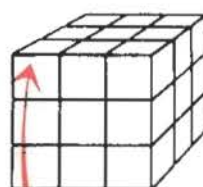
Step 1
Top
Right



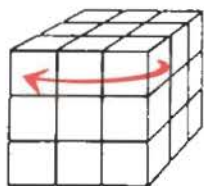
Step 2
Front
Clockwise



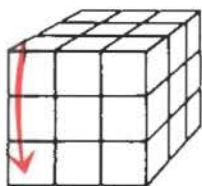
Step 3
Top
Left



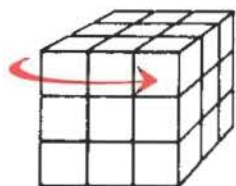
Step 4
Left
Side Up



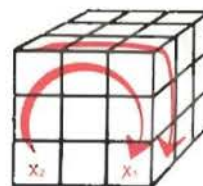
Step 5
Top
Left



Step 6
Left
side Down



Step 7
Top
Right



Step 8
Front
Clockwise (2 turns)

Now *check* all four front corners to confirm that they are all in place.

DO NOT proceed to Part III unless you still have the starting condition and the additional four corner sub-cubes are

in their correct position. None, one or two of these corners may also be color aligned. Part III will tell you how to proceed.

PART III - COLOR ALIGN THE BOTTOM 4 CORNERS.

A. The *object* of this 8 move process is to color align the remaining corners. At this point, all 8 corner sub-cubes are in correct position, but 4 or less of them are *not color aligned*.

First, remember to keep the same orientation with the solved blue side at the back (away from you). This 8 step

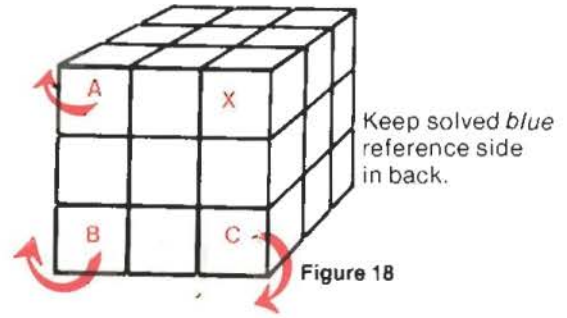
process rotates 3 of the four front corners on their axis. See diagram. (Figure 18). It keeps corners A, B and C in position but rotates the 3 colors on each corner. The process rotates the 3 corner sub-cubes A, B and C only, however, before you proceed you must establish the correct initial orientation (See a, b, c on following page.)

INITIAL ORIENTATION

a. If after you complete Part II, you find you have **one** of the corner sub-cubes color aligned, turn the *whole cube* so that *that* corner appears in the position marked (X). Do steps 1-8 below.

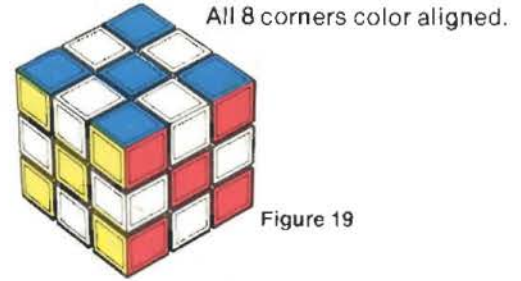
b. If you have **two** corners aligned, then turn the whole cube so that they fall in the position marked (A) and (B) or (A) and (C). Do steps 1-8 below.

c. If **none** of the front corners are color aligned then it doesn't matter. Do steps 1-8 below.



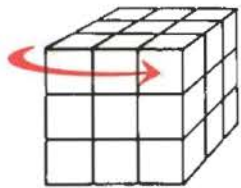
This process must be repeated several times (usually 2 to 4 times) until all 8 corners are color aligned with reference to their center cubes.

Check for color aligned corners each time you do steps 1-8, then refer to a, b or c above before repeating the process. You will know that all 8 corners are in color alignment when every side of the cube shows at least 5 squares of the same color in an "X'ed" pattern. See figure 19.

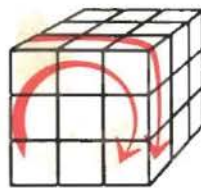


Remember, first check how many corners are color aligned to make sure you are in the correct starting position. See a, b and c above. As you do the procedure, be sure to grasp

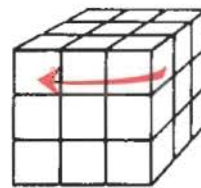
the non-moving two thirds of the cube firmly to maintain your starting orientation (correct solved blue side in back.) Failing to do so will put you back to Part I.



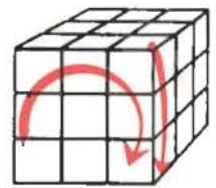
Step 1
Top Right



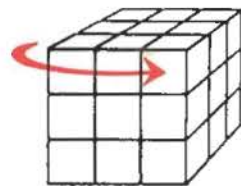
Step 2
Front Clock-
wise (2 turns)



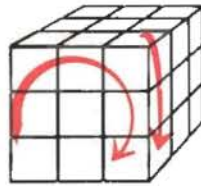
Step 3
Top Left



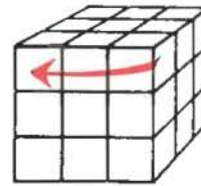
Step 4
Front
Clockwise



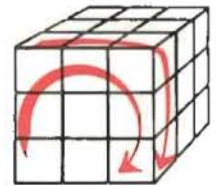
Step 5
Top Right



Step 6
Front Clock-
wise



Step 7
Top Left



Step 8
Front Clock-
wise (2 turns)

After you do steps 1-8, check how many corners are color aligned. Don't worry if you had 2 corners color aligned and you lost one or both because the last time you run the process only one corner should be color aligned.

Now repeat steps 1-8 until all 8 corners become color aligned as in figure 19 above.

DO NOT proceed to Part IV unless one side, eight corners and six centers are in their solved condition. (In correct position and also color aligned).

PART IV - SOLVE TWO SIDES OF THE CUBE

The *object* of this part is to solve 2 opposite sides of the cube by using the *guide piece* to solve one bottom middle-edge piece at a time.

When you solved the first (blue) side you were instructed to leave one middle-edge piece out (unsolved). This missing

piece will now act as a *guide piece*. See figure 20A below.

Turn the *whole cube* so your blue reference color appears *on top*. Keep blue on top and turn the *whole cube* again until the guide piece is facing you as in figure 20A below.

A. Choosing a Target Piece

Now turn *just the bottom row* of the cube until an out of position bottom middle-edge piece appears *directly below the guide piece* as in figure 20B. This is the **TARGET** piece you will solve. Notice the two common colors of the 2 lower front corners. In the example in figure 20B the two common corner colors are yellow and orange. This means that the correct bottom middle-edge piece for this spot *must be yellow and orange*. In this case, the correct piece is located on the middle row.

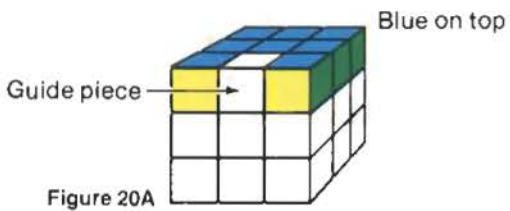
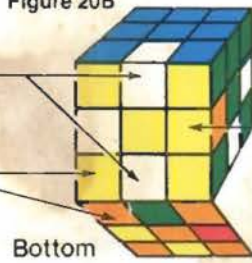


Figure 20B

Notice the guide piece is directly over an out of position bottom middle-edge piece (white & green).

2 common colors of lower front corners (yellow & orange).



Correct bottom middle-edge piece for this example on middle row.

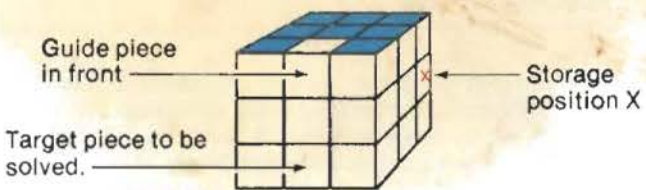
At this point, choose a bottom middle-edge piece to solve by positioning it *under the guide piece*. Call this the **TARGET** piece.

Now check the **2 common colors** of the corners on either side of the **TARGET** piece. Only the **CORRECT MISSING** piece will have these two colors. Find it! But remember to keep the blue reference color on top and the guide piece facing you.

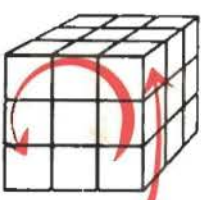
B. Locating and Storing CORRECT MISSING Piece.

The **CORRECT MISSING** piece will *always* be found in one of 3 places: (a) *on the middle row* as in figure 20, (b) *on the bottom row* out of place or (c) *on top* in the *guide piece* position.

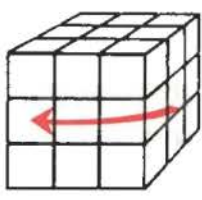
Once you find the **CORRECT MISSING** piece you must *store* it in order to solve the **TARGET** piece. The **CORRECT MISSING** piece must be *stored* on the middle row in the storage position marked (X) in figure 21. How you store this piece depends on where it is located.



a. If you find the **CORRECT MISSING** piece on the *middle row*, then just turn the *middle row* until it falls into storage position (X). Then follow steps 1-3 or steps 1-3D below.

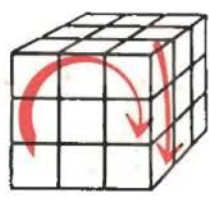


Step 1
Front Counter
Clockwise



Step 2
Center Left

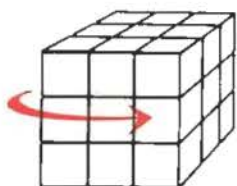
STOP!
See
Note
Below



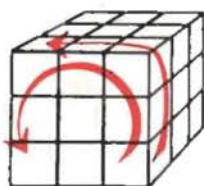
Step 3
Front Clockwise

Note: Do not go on to step 3 unless the missing piece drops into correct color alignment after step 2. If after step

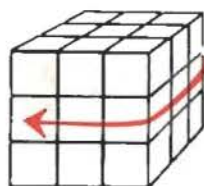
2 the missing piece appears in position but *out* of color alignment, then proceed to steps 3A-3D.



Step 3A
Center Right



Step 3B
Front Counter
Clockwise (2 turns)



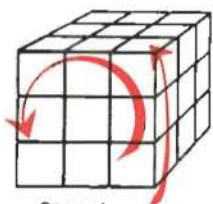
Step 3C
Center Left
(2 turns)



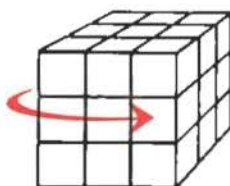
Step 3D
Front Counter
Clockwise

b. If you find the CORRECT MISSING piece on the bottom, first, turn just the bottom row until the correct missing piece appears under the GUIDE piece. (This will move your

TARGET piece out of position temporarily.) Then follow steps 1-3 below.



Step 1
Front Counter
Clockwise



Step 2
Center Right



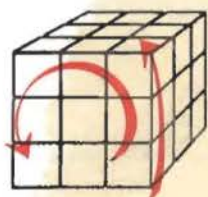
Step 3
Front Clockwise

Note: After Step 3 the CORRECT missing piece will be stored in position X, as shown in step 3.

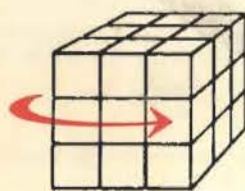
NOW TURN THE BOTTOM ROW UNTIL THE TARGET PIECE APPEARS UNDER THE GUIDE PIECE AGAIN.

Go back to section (Ba) above and follow steps 1-3 or 1-3D.

c. If the correct missing piece is the guide piece then follow steps 1-3 below:

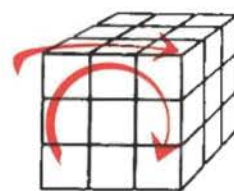


Step 1
Front Counter
Clockwise



Step 2
Center
Right

STOP!
See
Note
Below



Step 3
Front Clockwise

Note: Do not go on to step 3 unless the missing piece drops into correct color alignment after step 2. If after step 2, the missing piece appears in position but out of color alignment, then go back to section (A) above and follow steps 3A-3D.

Solve all missing bottom edge pieces until you succeed in color aligning the entire bottom of the cube. At this point, you will have the bottom solved and the (blue) top solved except for the guide piece. (See figure 22).

Now that the bottom is solved, you must solve the missing guide piece to complete the top. Find the correct top middle-edge piece. This piece can be found only in one of 2 places. (A) on the middle row or (B) already in position on top but not color aligned.

(A) If you find the missing top middle-edge piece on the middle row then move it to position #2 as in figure 22. In the example in figure 19 the correct missing top middle-edge piece is red and blue and it appears in position #2.

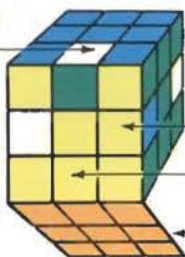
Once you move your correct top middle-edge piece to position #2, follow steps 1-7.

(B) If your last top middle-edge piece (guide piece) is already in position but is not color aligned, follow steps 1-7 THEN TURN THE CENTER ROW RIGHT 90° AND REPEAT STEPS 1-7 AGAIN.

Top (Reference Color) Blue

(1) Guide piece

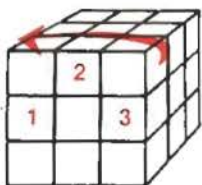
Figure 22



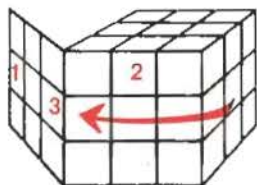
(2) Correct Top Middle edge piece

(3) Bottom middle edge piece color aligned

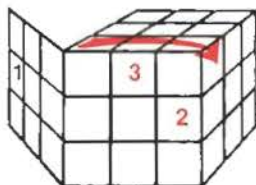
Bottom completely solved



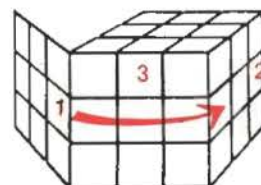
Step 1
Front Counter
Clockwise



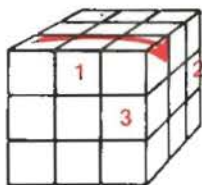
Step 2
Center Left



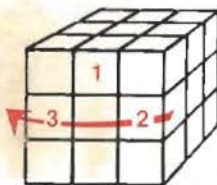
Step 3
Front Clock-
wise



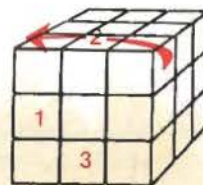
Step 4
Center Right



Step 5
Front Clockwise



Step 6
Center Left



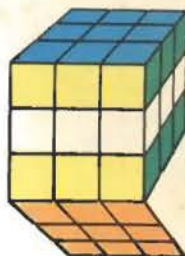
Step 7
Front Counter
Clockwise

Note: If after step 7 the guide piece falls into position but is *not color aligned*, REPEAT STEPS 1-7 THEN TURN CENTER ROW RIGHT 90° and REPEAT STEPS 1-7 AGAIN.

Now you should have both the top and the bottom of the cube completely solved as shown in figure 23, with blue on top.

Both top and bottom thirds are completely solved.

Figure 23



PART V - POSITION AND COLOR ALIGN ALL REMAINING OUT OF PLACE MIDDLE-EDGE PIECES.

New Orientation

Turn the *whole cube* so that the 2 *solved* sides appear on the left and right sides. See figure 24.

Keep this new orientation fixed, and turn *just the center* up and away until all 4 remaining center squares fall into correct color alignment as in figure 24. *Note: Blue on left side.*

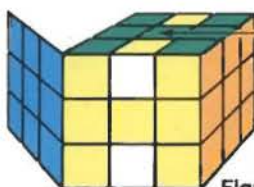


Figure 24

all centers in correct color alignment.

At this point, you will find one of five things will happen:

Case 1 - Four middle-edge pieces out of place and not color aligned. Use process (A) on following page twice.

Case 2 - Three middle-edge pieces out of place and not color aligned. Use process (A).

Case 3 - Four middle-edge pieces in position but not color aligned. Uses process (B) on page 14 twice.

Case 4 - Three middle-edge pieces out of place and one piece in position but not color aligned. Use process (A) then process (B).

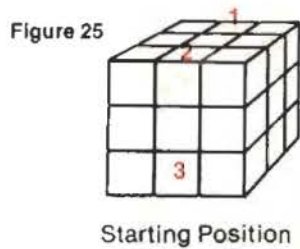
Case 5 - Two middle-edge pieces in position but not color aligned. Use process (B).

A. Process A

The goal of Process (A) is to place all remaining unsolved middle-edge pieces into their correct positions.

The four step procedure outlined below will move three middle-edge sub-cubes, causing them to exchange their positions with each other, without disturbing other sub-

cubes. Figure 25 shows the three side sub-cubes that will exchange positions. The position exchange occurs as follows: the side sub-cube marked 1 will move to the position occupied by side sub-cube marked 2; the side sub-cube marked 2 will move to the position marked 3; and the side sub-cube marked 3 will move to the position marked 1.

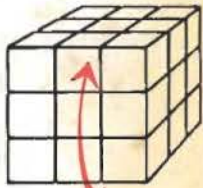


1 moves to 2
2 moves to 3
3 moves to 1

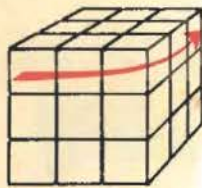
Now check all the remaining out of place middle-edge pieces and pick 3 that will fall into correct place if exchanged.

Remember, first find the 3 out of place middle-edge cubes that will fall into correct position if they are exchanged in the manner below:

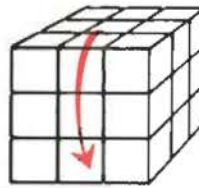
Be careful to maintain the starting orientation when using the procedure, hold both solved outside thirds firmly in steps 1 and 3.



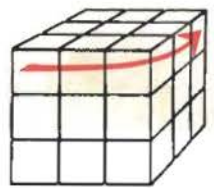
Step 1
Center Up
& Away



Step 2
Top Right
(2 turns)



Step 3
Center Back
Down



Step 4
Top Right
(2 turns)

Repeat Process (A) steps 1-4 above until either the puzzle is solved OR you find you have left one pair of middle-edge pieces that are in position but not color aligned. To solve this last pair go on and do process (B) steps 1-12 below.

If you find you are in Case 4, you will have 2 pairs of middle-edge pieces in position but not color aligned as in figure 26A. Process (B) will solve them one pair at a time.

Figure 26A shows a pair of top middle-edge pieces in position but not color aligned. (Before Process B).

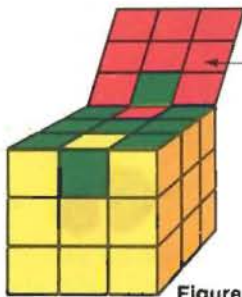


Figure 26A

back side

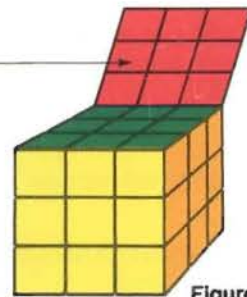


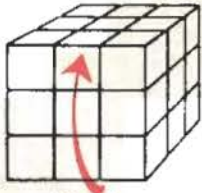
Figure 26B

Figure 26B shows that same pair color aligned. The whole cube is solved. (After Process B).

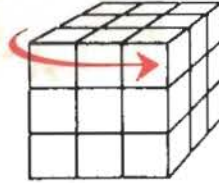
B. Process B

This 12 step process is known as Rubik's Maneuver after Erno Rubik, the inventor of the Cube.

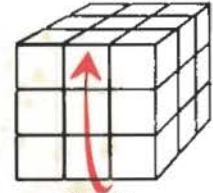
Before you run Process (B), the 2 middle-edge pieces whose colors are to be flipped must be opposite each other on top of the cube as shown in figure 26A.



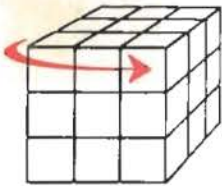
Step 1
Center Up
& Away



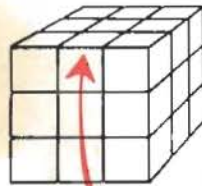
Step 2
Top Right



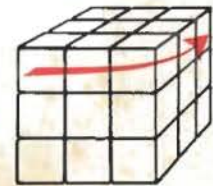
Step 3
Center Up
& Away



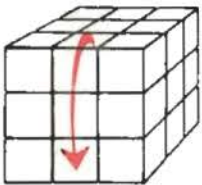
Step 4
Top Right



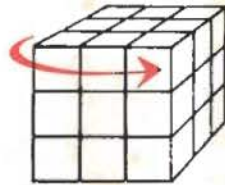
Step 5
Center Up
& Away



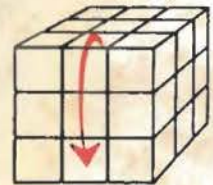
Step 6
Top Right
(2 turns)



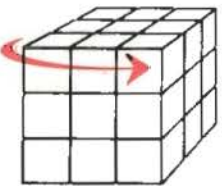
Step 7
Center Back
Down



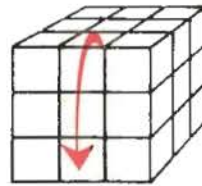
Step 8
Top Right



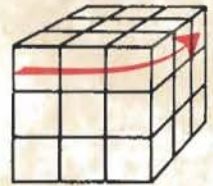
Step 9
Center Back
Down



Step 10
Top Right



Step 11
Center Back
Down



Step 12
Top Right
(2 turns)

Repeat Rubik's 12 step process if you have another pair in position that needs to be color aligned.

Now you have solved the cube - Congratulations, you're a CUBIST! Mix it up and start again.



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