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| Jockey Club STEAM Education Resources Sharing Scheme |
| **Making a Rubik’s Cube** |
| Activity Book |

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**CUBrodic Table 扭轉新元素**

**About the module**

There are five units in this module, including:

1. Engineering: Mechanism and Design of a Rubik’s Cube
2. Technology: 3D Modelling and Printing a Rubik’s Cube
3. Science: Elements, Atoms and Periodic Table
4. Art: Design Stickers for Decorating a Rubik’s Cube
5. Mathematics: Rubik’s Cube Solver

**Aims**

* To raise students’ interest in STEAM by building a Rubik’s cube with chemical element stickers
* To appreciate the principles of Chemistry and Mathematics

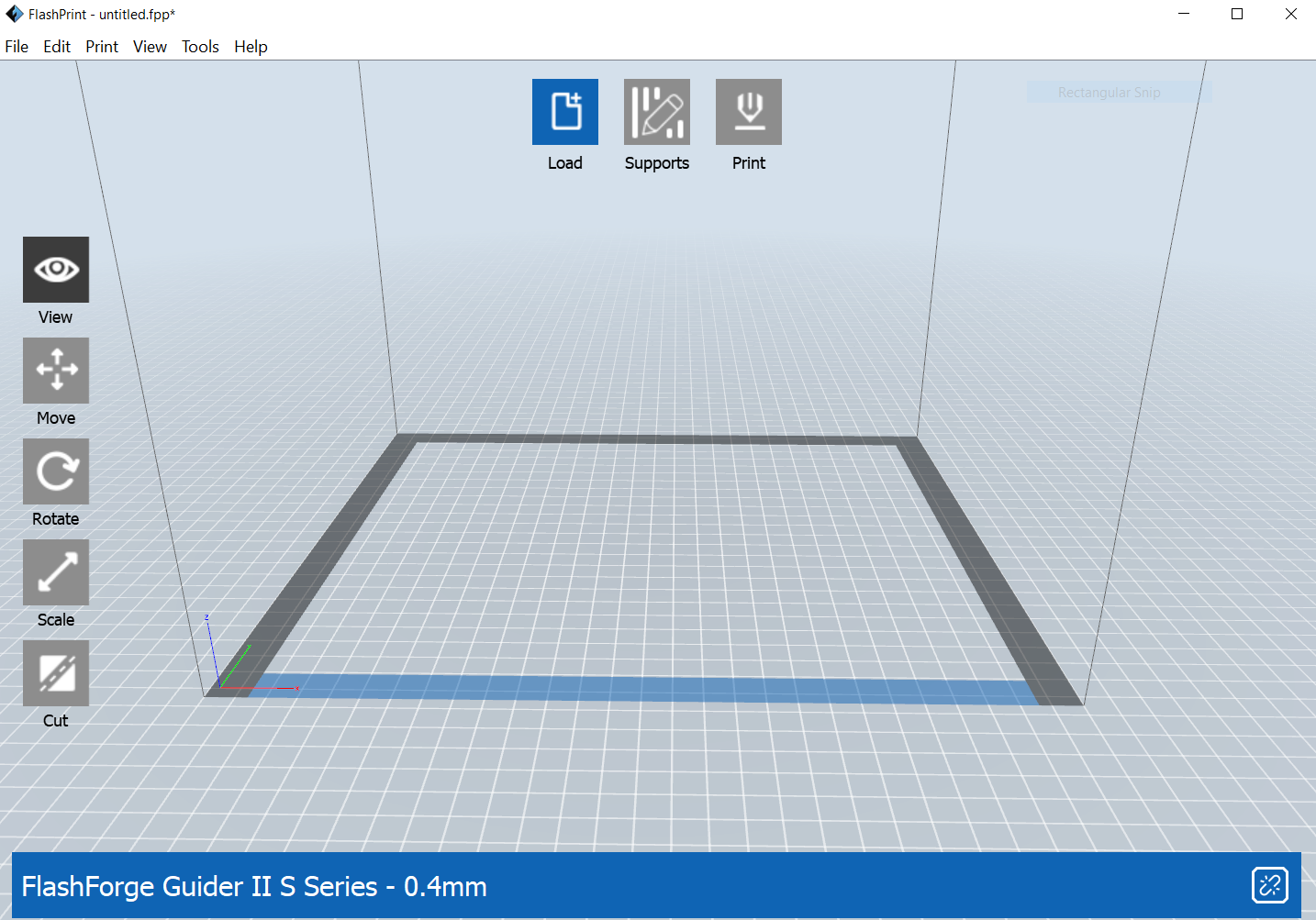
|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Rubik’s Cube |  | Periodic Table of Elements |  | CUBrodic Table |
| A picture containing indoor, computer, table, desk  Description automatically generated | + |  | = |  |

**Mapped Key Learning Areas**

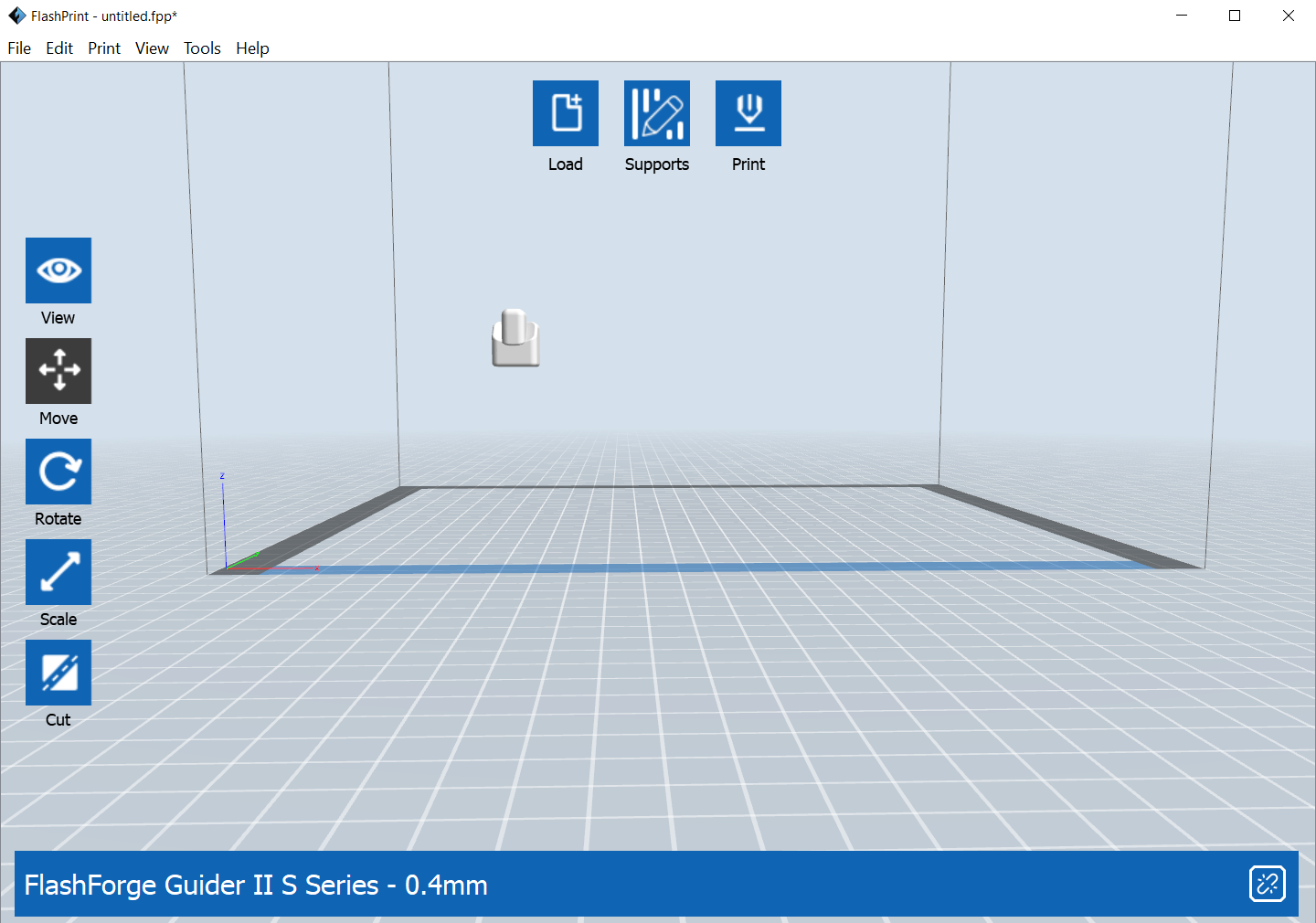
| Unit | Science Education | Technology Education | Mathematics Education | Arts Education | Others |
| --- | --- | --- | --- | --- | --- |
| 1 |  | TK1.1 Hardware and software  TK5.10 Appropriate choice and use of tools, equipment and machines for the realisation of design solution |  |  |  |
| 2 |  | TK1.1 Hardware and software  TK6.3 Production processes in various fields  TK16.3 Information processing and information processing tools  TE7.4 Computer-aided manufacturing |  |  |  |
| 3 | SJ13.1 Atoms and elements  SJ13.2 Periodic Table |  |  |  |  |
| 4 |  |  |  | computer-aided design, colour, font, composition and structure of graph(s), decoration, creativity |  |
| 5 |  |  |  |  | MS15.1 – MS 15.5 Permutations and combinations |

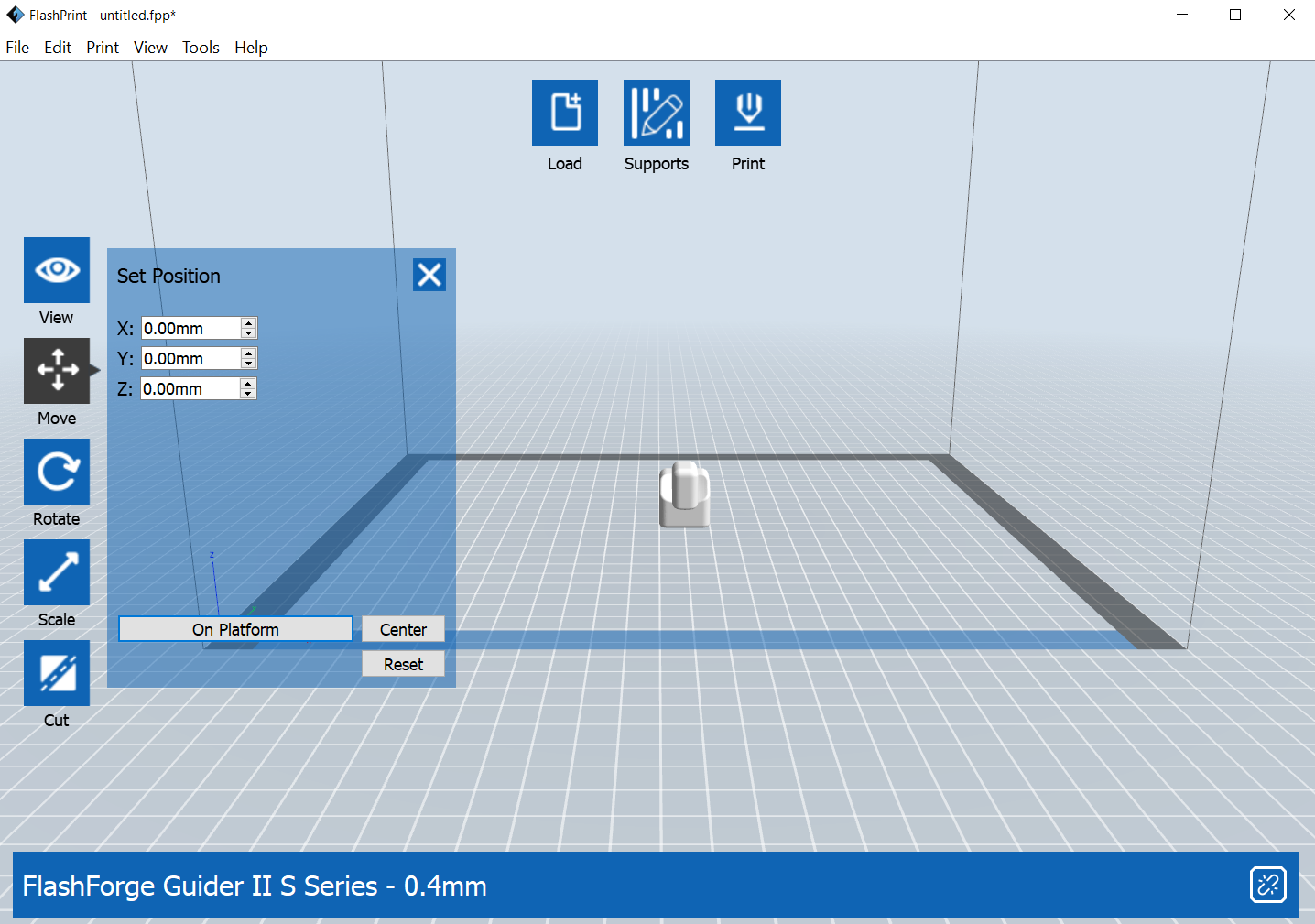
**Operation of FlashPrint Software**

1. Load your stl. file by pressing ‘’Load’’.

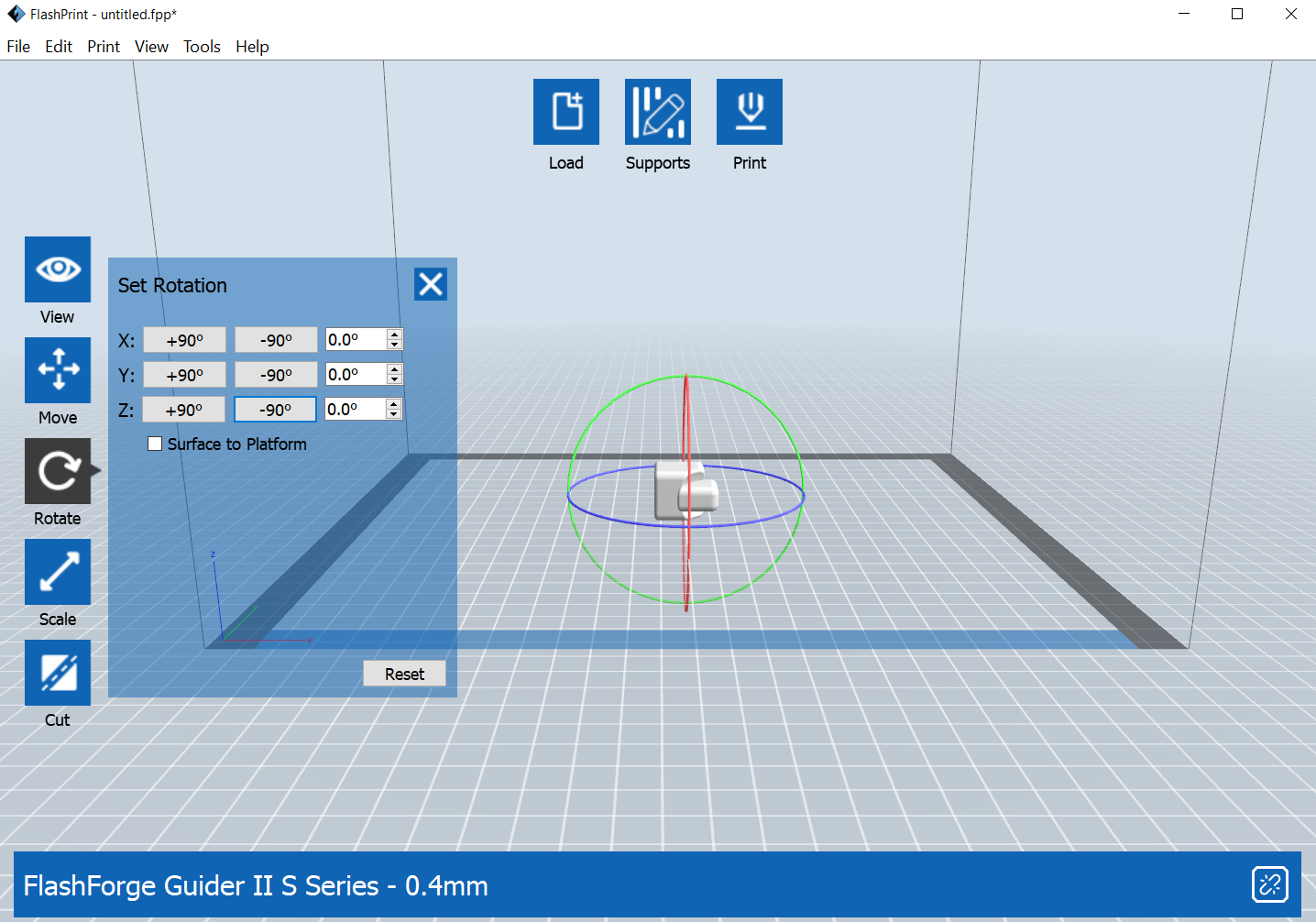


1. Select “Move” and then place your design on the surface by pressing ‘’center’’ and ‘’On platform’’.

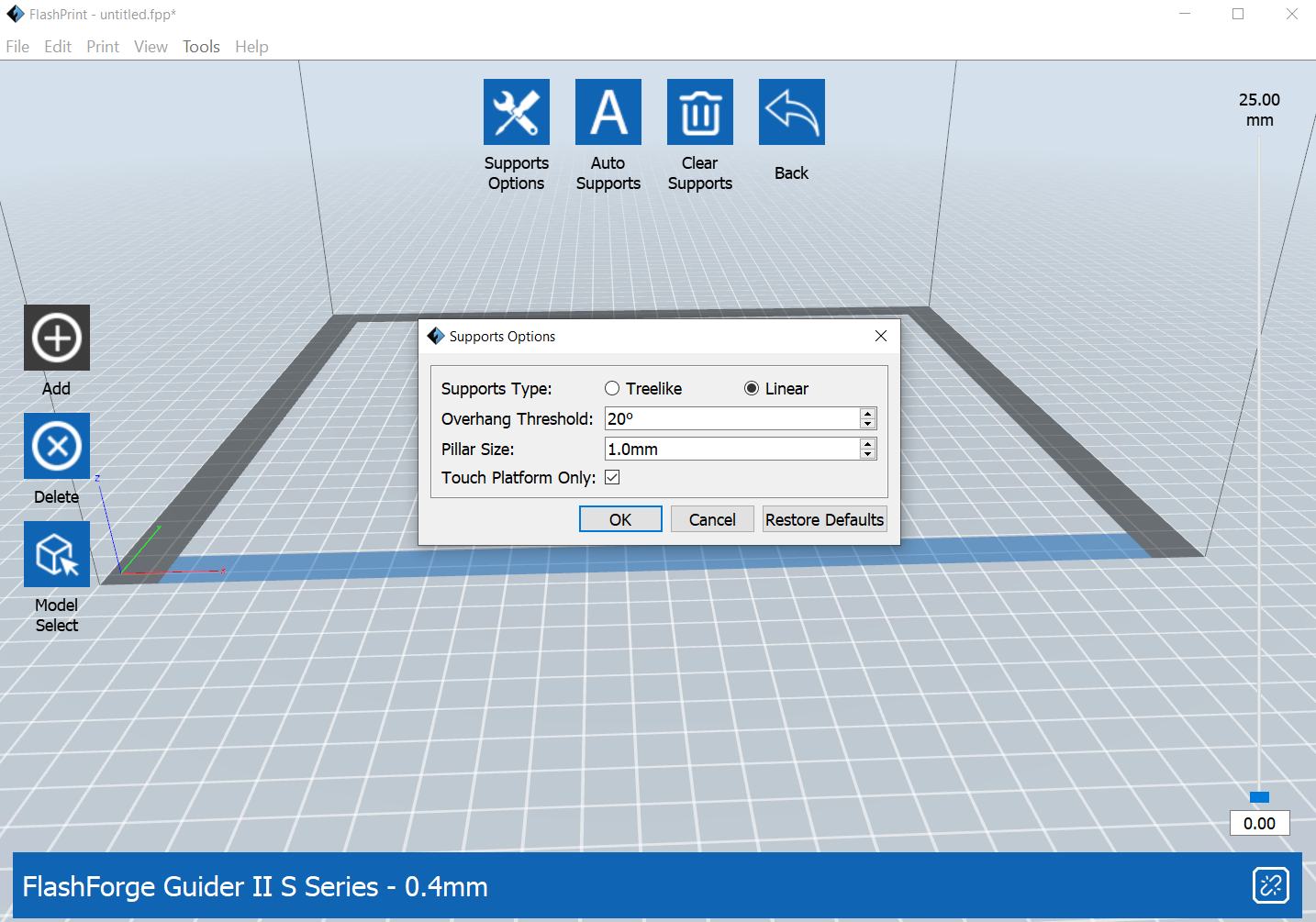




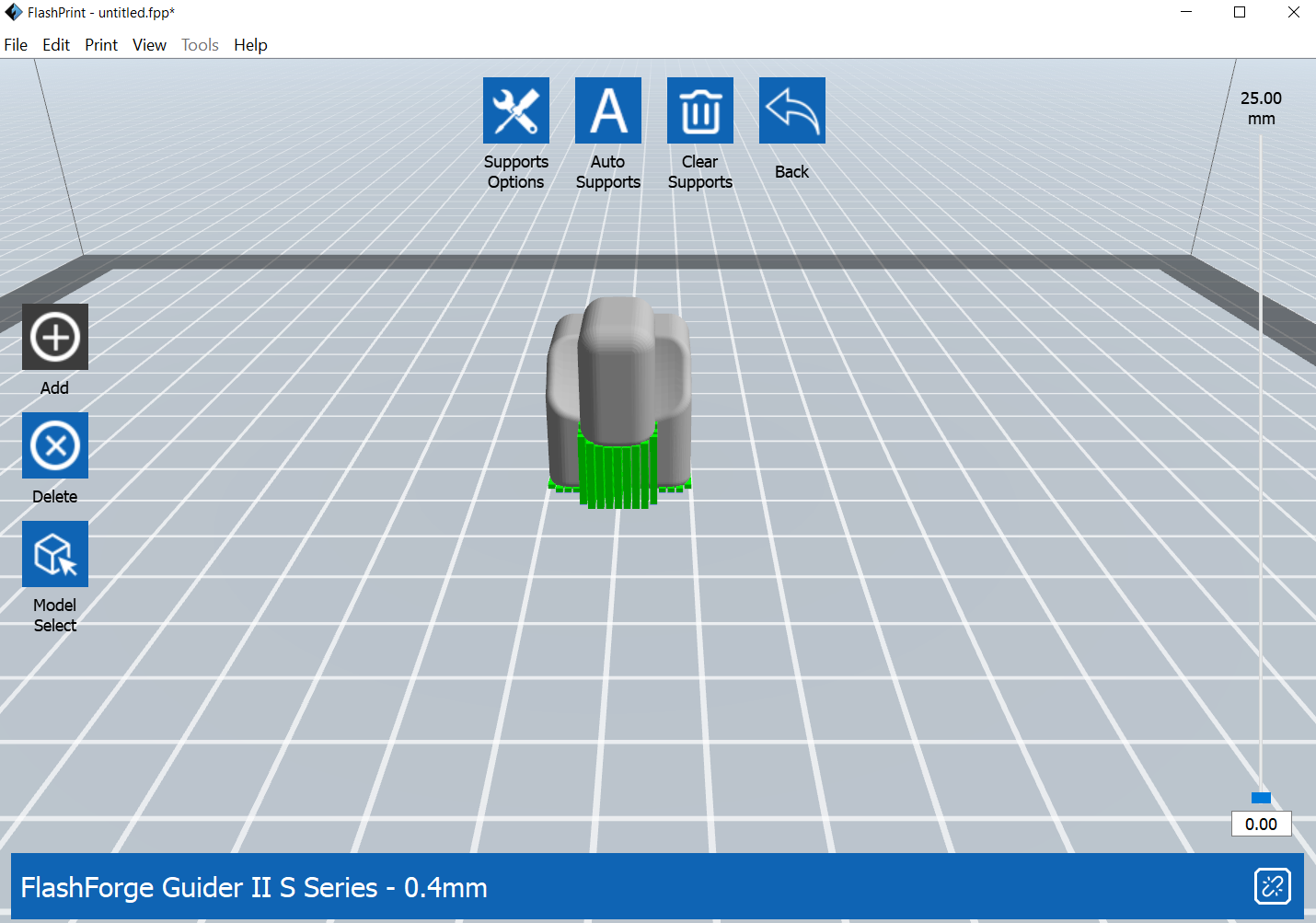
1. Rotate the design to the desired orientation.



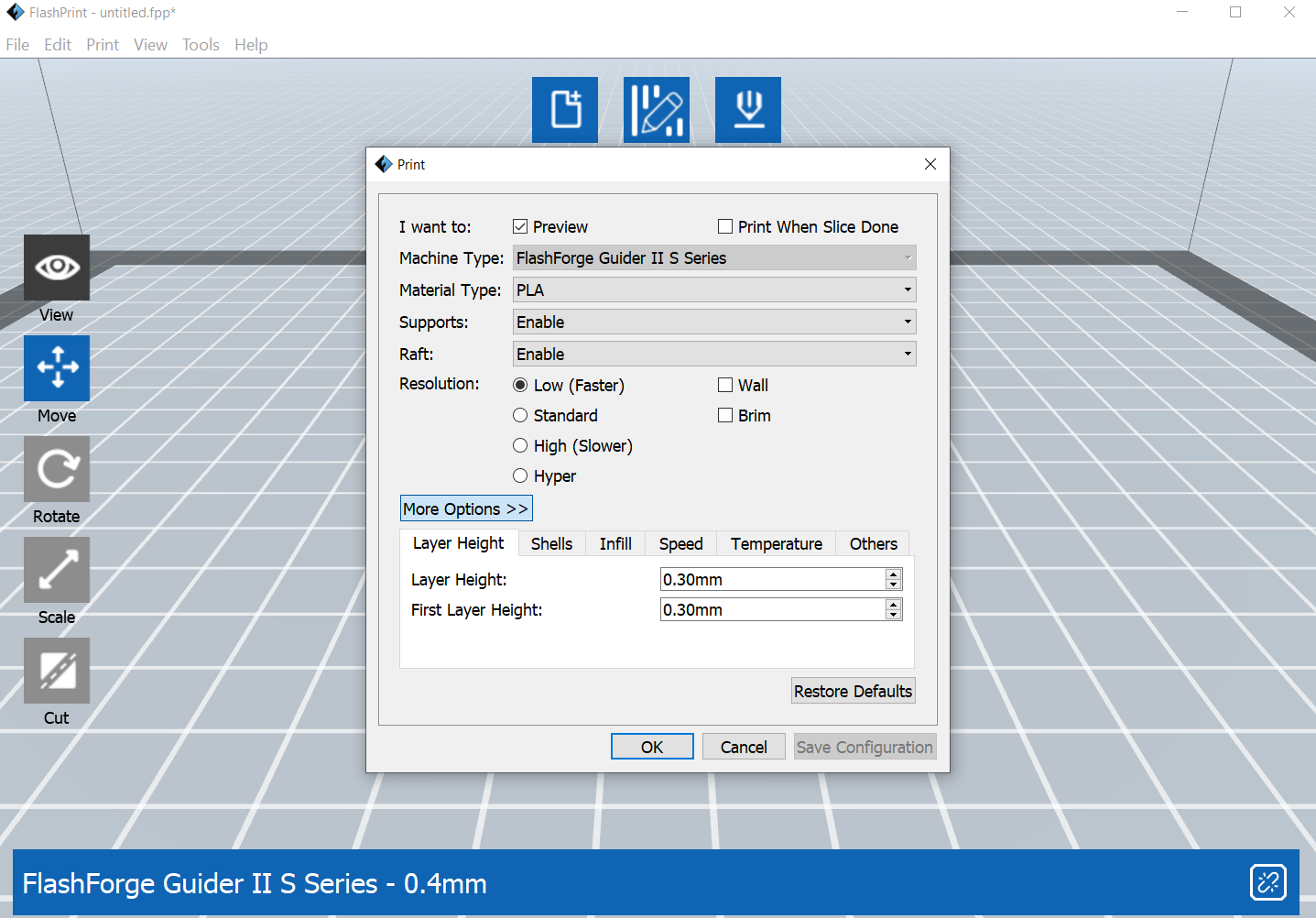
1. Select ‘Support’ and then ‘support options’. Choose the support type, and then click ‘OK’.



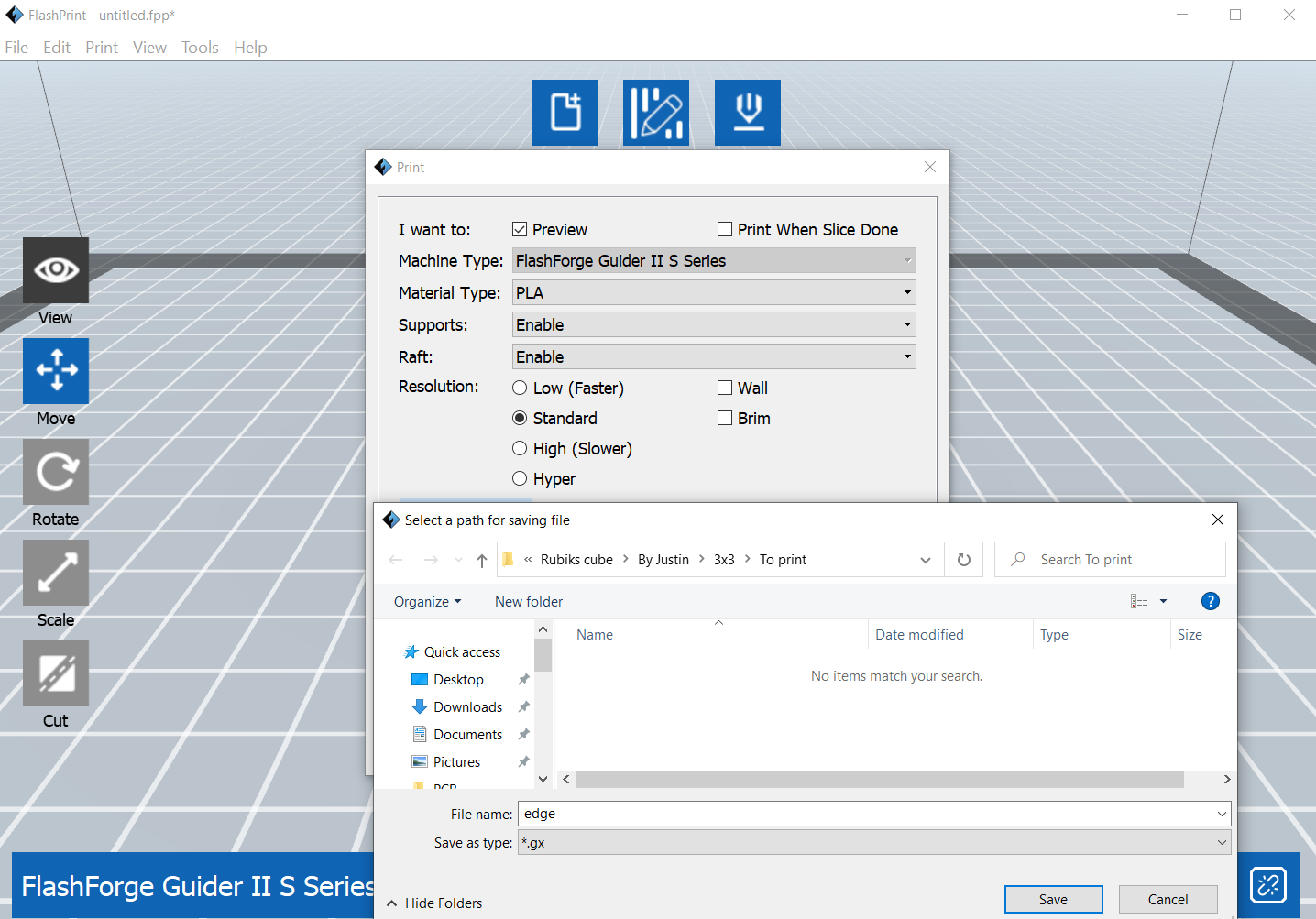
1. Click “Auto support” and then “Back”.



1. Click “Print” to set the resolution. Input relevant information for infill/speed/temperature parameters.



1. Press “OK” to save the file as the gx format as the input file for the 3D printer.



**Points to note for 3D printing**

1. Aligning the objects on the printing platform
   * Identifying the bottom surface of the objects
   * Moving the objects (to centre the object and touch the platform)
   * Rotating the objects (to achieve optimum orientation)
2. Addition of supports
   * Introducing linear and treelike supports
   * Choosing the type of supports
3. Addition of rafts
   * Introducing rafts
4. Choosing the printing resolution
5. General settings for 3D printing
   * Printing material: PLA
   * Infill percentage and speed
   * Setting temperatures of extruder and platform
6. Saving as 3D printing input file (the gx file format)

|  |  |
| --- | --- |
| **3x3 Rubik’s Cube 3D printing file (in STL format)** |  |

**Assemble a 3x3 Rubik’s Cube**

**Parts**

|  |  |  |
| --- | --- | --- |
|  |  |  |
| Cross (X)  1 no. | Mid (M)  6 nos. | 3M x 16mm and Spring  6 nos. |
|  |  |  |
| Edge (E)  12 nos. | Corner (C)  8 nos. | Lid (L)  6 nos. |

**Assemble Steps**

|  |  |  |
| --- | --- | --- |
| 1 | 4 | 7 |
| A close up of a device  Description automatically generated | A close up of a device  Description automatically generated |  |
| 2 | 5 | 8 |
|  | A close up of a device  Description automatically generated | A close up of a device  Description automatically generated |
| 3 | 6 | 9 |
| A close up of a logo  Description automatically generated |  | A picture containing yellow, colorful, man, sitting  Description automatically generated |

**Design Your Own Rubik’s Cube Stickers**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| |  |  |  | | --- | --- | --- | |  |  |  | |  |  |  | |  |  |  | | |  |  |  | | --- | --- | --- | |  |  |  | |  |  |  | |  |  |  | |
| |  |  |  | | --- | --- | --- | |  |  |  | |  |  |  | |  |  |  | | |  |  |  | | --- | --- | --- | |  |  |  | |  |  |  | |  |  |  | |
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**3x3 Rubik’s Cube Solver**

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| --- | --- | --- |
|  |  |  |

***The Magic Words***

|  |  |  |
| --- | --- | --- |
|  |  |  |
| **U**  Turn the UP layer | **L**  Turn the LEFT layer | **F**  Turn the FRONT layer |
|  |  |  |
| **D**  Turn the DOWN layer | **R**  Turn the RIGHT layer | **B**  Turn the BACK layer |

***Exactly the same but a bit different***

|  |  |  |
| --- | --- | --- |
|  |  |  |
| **u**  Turn the INNER-UP layer | **l**  Turn the INNER-LEFT layer | **f**  Turn the INNER-FRONT layer |
|  |  |  |
| **d**  Turn the inner-down layer | **r**  Turn the inner-right layer | **b**  Turn the inner-back layer |

|  |  |  |
| --- | --- | --- |
| ***3 symbols*** |  | No symbol means a CLOCKWISE turn of a face |
|  |  | This symbol means a COUNTER-CLOCKWISE turn of a face |
|  |  | This symbol describes a 180 degrees turn of a face |

**Exercise**

***Repeat this 5 times***

**R U R U’**



***Repeat this 6 times***

**R D’ R’ D**



***To Solve the First Layer***

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Center |  | Edge |  | Corner |

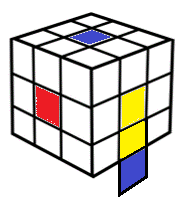
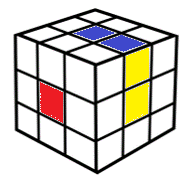
Step #1 Fix the blue colour edge

Before using  **#1a** and **#1b**,

 Place the blue face center on the top.

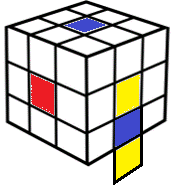
 Put the blue face edge to the DOWN layer first.

 Use **D, D’ or D2** to turn the cube into one of the situations below.



Same color

**#1a** **R2**

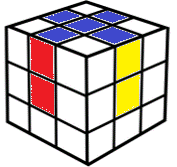


Repeat **#1a** or **#1b**

for the other 3 faces

Same color

**#1b** **R’ d’ R d**

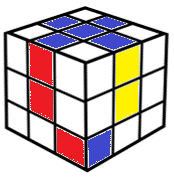


Step #2 Fix the blue face which is at the corner

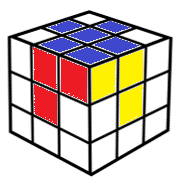
 You can use the following formulas according to your situation.

Before using **#2a** and **#2b,**

 you should put the blue face in the right place using **D, D’or D2**.

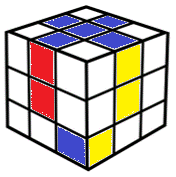


Same color



(Blue face facing RIGHT side)

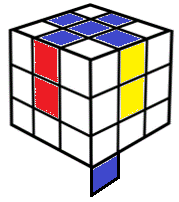
**#2a** **R’ D’ R**



Same color

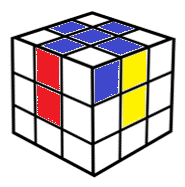
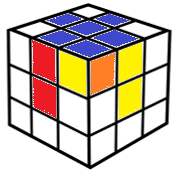
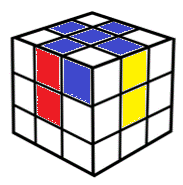
(Blue face facing FRONT side)

**#2b** **F D F’**



(Blue face facing DOWN)

**#2c** **R’ D R D2**  Put the blue face in the right place using **D, D’or D2**  Move **#2a**

Not match

Not match

OR

OR

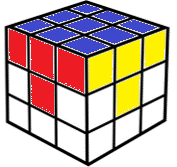
(Blue color at the UP layer)

**#2d R’ D2 R**

 Put the blue face in the right place using **D, D’or D2**.

 Move **#2a**, **#2b** or **#2c** respectively.

Repeat **#2a**, **#2b**, **#2c** **or #2d** for each of the 4 faces, you will finish the first layer.



***To solve the Second Layer***

|  |  |  |
| --- | --- | --- |
|  |  |  |

|  |  |  |
| --- | --- | --- |
| 2  1  3 |  | 2  1  3 |

Step #1 **r R’ U2 r’ R U2**

|  |  |  |
| --- | --- | --- |
| 2  1 |  | 2  1 |

Step #2 **U2 L2 U2 L2 U2**

|  |  |  |
| --- | --- | --- |
|  |  |  |

Step #3 **U’ r’ R U F2 U’ r R’ U**

***Relax!! It’s fine as long as they are at the spot. We will fix the colour later at Step #9***

***To solve the Third Layer – Corner***

|  |  |  |
| --- | --- | --- |
|  |  |  |

|  |  |  |
| --- | --- | --- |
| 2  1 |  | 2  1 |

Step #4 **U’ F U L’ U L U’** Move Step #5

|  |  |  |
| --- | --- | --- |
|  |  |  |

Step #6 **U’ R2 U R U’ R U R2**

Situations for Step #5

* One **GREEN**: Place on the top right and move Step #7
* Two **ADJACENT GREENS**: Place on the left side and move Step #7
* Others: Proceed to Step #7 directly

***To solve the Third Layer – Edge***

|  |  |  |
| --- | --- | --- |
|  |  |  |

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  |  | **For clockwise swap**  Step #8a |  | **For counter-clockwise swap**  Step #8b |
| 2  1  3 |  | 1  2  3 |  | 1  2  3 |

Step #6a **F2 U L R’ F2 L’ R U F2**

Step #6b **F2 U’ L R’ F2 L’ R U’ F2**

|  |  |  |
| --- | --- | --- |
|  |  |  |

Step #7 **r R’ U r R’ U r R’ U2 r’ R U r’ R U r’ R U2**

**Congratulations!**