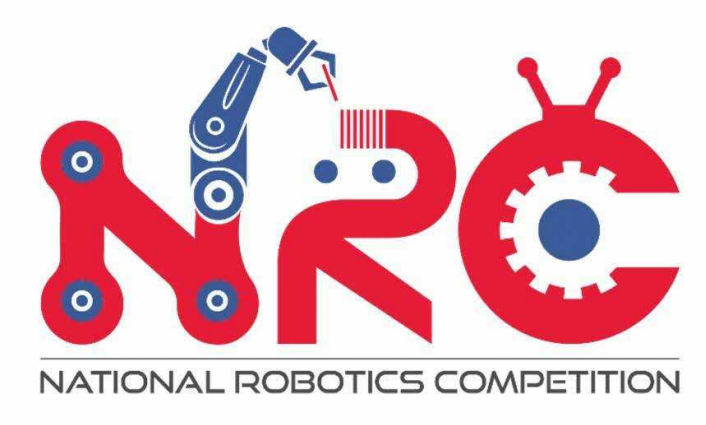


NRC 2023 REGULAR CATEGORY

Upper Primary and Secondary

GAME RULES

Version: 9 March 2023

Organiser:

Sponsored by:

Ministry of Education
SINGAPORE

Supported by:

NRC 2023 Regular Category - Upper Primary and Secondary

CHALLENGE BOOKLET CHANGE LOG

Version	Release Date	Description
1.0	10 March 2023	Official Challenge Booklet release

Contents

PART ONE – GAME DESCRIPTION

PART ONE – GAME DESCRIPTION

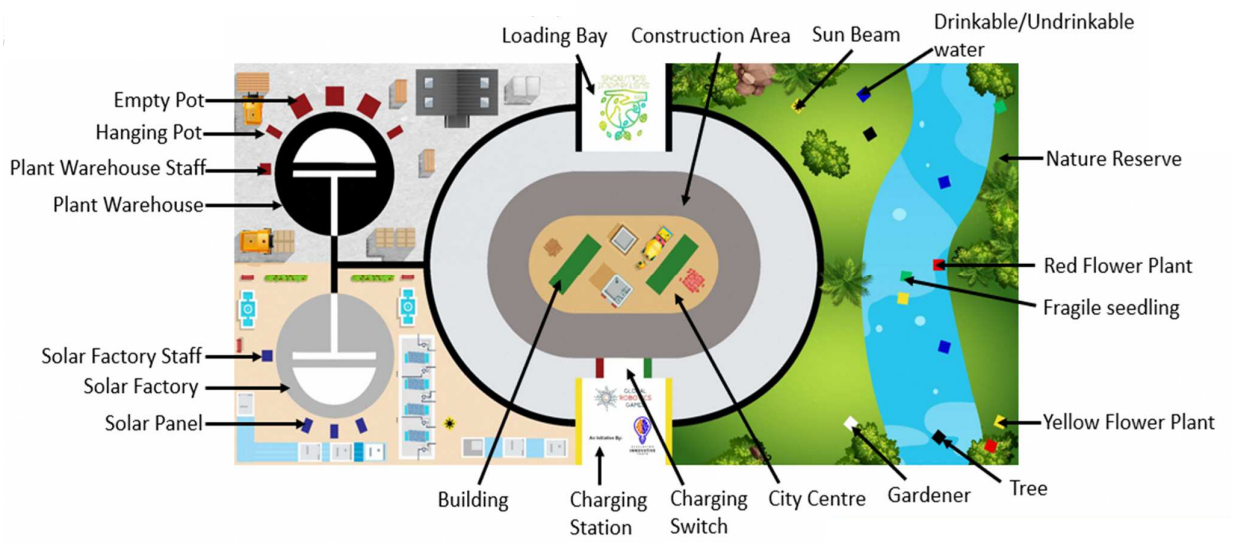
1. Introduction

A Green City is a city designed with consideration for social, economic and environment impact, and to be a resilient habitat for existing populations, without compromising the ability of future generations to experience the same.

Robots can support in the transportation of clean energy infrastructure such as solar panel and transportation of people. Robots can also support the construction of buildings to reduce the need of manpower and reduce the carbon footprint of buildings.

In this category, each team's robot is tasked to ferry humans, segregate potable, and non-potable water, replanting trees and constructing the green building. At the same time, they must work with existing construction equipment to aid with the construction of the green building.

2. Game Field



The following graphic above shows the game field with the different areas.

For more information about the table and game mat specifications, please refer to NRC 2023 Regular Category General Rules.

3. Sub-Category Game Rules

If there is any uncertainty during the robot attempt, the judge will make the final decision. The judge should decide in favour of the team if no clear decision is possible.

3.1 Pre-Run

- Robot and construction equipment will be inspected by referees according to the requirements prior to quarantine.
- Robot and Construction Equipment must be placed in the respective starting area so the projection of the robot on the game mat is completely within the start area (Robot in Charging Station and Construction Equipment in the Construction Area).
- Teams are allowed to make adjustments to the robot by hand only in the starting area.
- Teams are not allowed to enter data to a program by changing positions or orientation of the robot parts or to make any sensor calibrations of the robot.
- Referees are to inspect the placement of the Robot and Construction Equipment
- No wireless communication (Wifi, Bluetooth etc) is allowed.

3.2 Start of Robot Run

- Time begins when the judge gives the signal to start.
- Each robot attempt is 2 minutes run (120 seconds)

3.3 During Robot Run

Teams are allowed:

- To touch the robot or switch programs by hand after their robot comes to a complete stop and it is partially in the Loading Bay.
- To unload the props (Fragile Seedlings, Solar Panel, Red Flower Plants and Yellow Flower Plants and the Hanging Pots only) from the robot by hand after the robot comes to a complete stop and it is partially in the Loading Bay.
- To load the props (Fragile Seedlings, Red Flower Plants and Yellow Flower Plants and the Hanging Pots only) from the Loading Bay onto the construction equipment by hand.
- To resume their robot run only after the teams are done with the load/unloading of props.

Teams are not allowed:

- To touch the robot when the robot is moving.
- To reprogram and enter data into the robot during a robot run.
- To move the Construction Equipment by hand during a robot run.

3.4 Ending of Robot Run

A robot run will end if…

- The 2 minutes mark is up (120 seconds).
- The robot has completely left the game table.
- The robot or team has violated the rules or regulations.
- A team member shouts “STOP”, and the robot does not move anymore. If the robot is still moving, the robot attempt will only end once the robot stops by itself or is stopped by the team or judge.

After the robot run, referees will score the attempt. Teams are required to sign off the scores noted on the scoring sheet (on paper or digital). Once the score is signed off no further changes are possible.

If a team does not want to sign off after a certain period of time, the judge can decide to disqualify the team for this round. It is not allowed for a team coach to join the discussion with judges on the scoring of the run. Video or photo proofs will not be accepted.

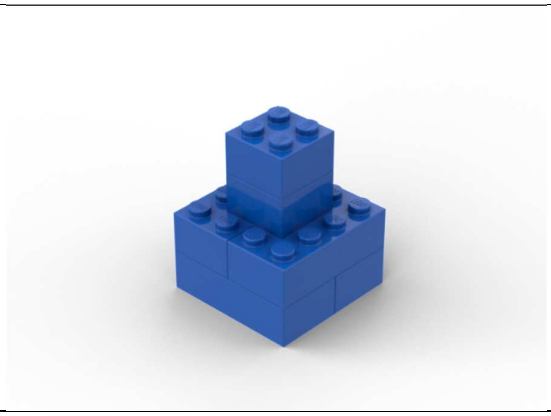
If a team finishes an attempt without having solved a (partial) task that yields positive points, the time of that run will be set at 120 seconds.

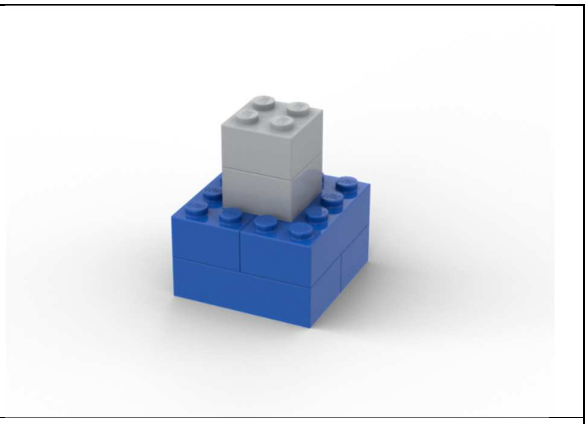
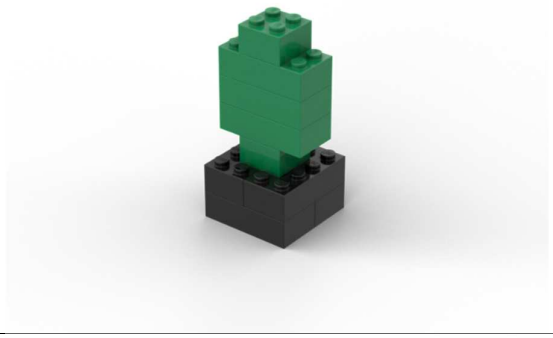
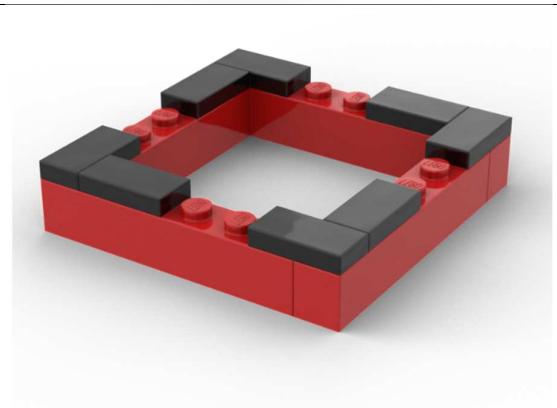
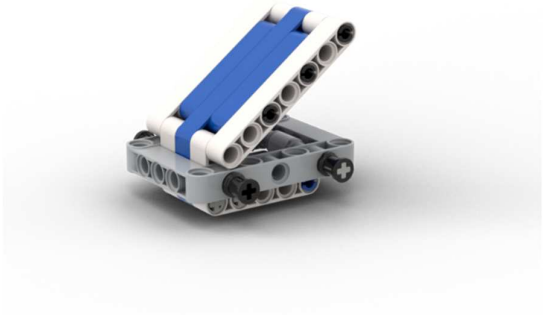
The ranking of teams depends on the overall tournament format. For example, the best attempt out of two rounds could be used and if competing teams have the same points, the ranking is decided by the record of time.

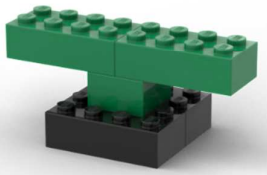
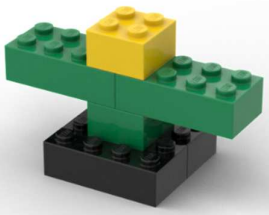
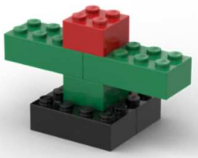
3.5 Construction equipment:

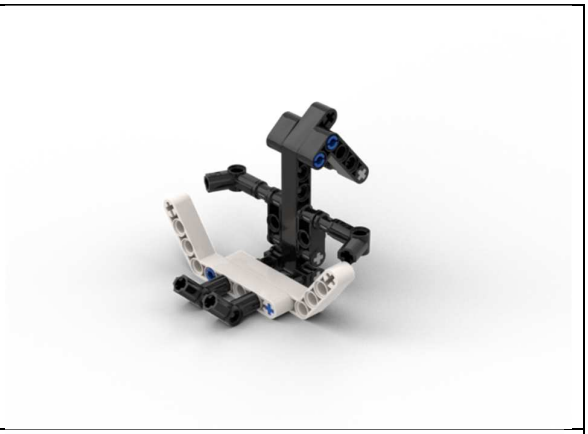
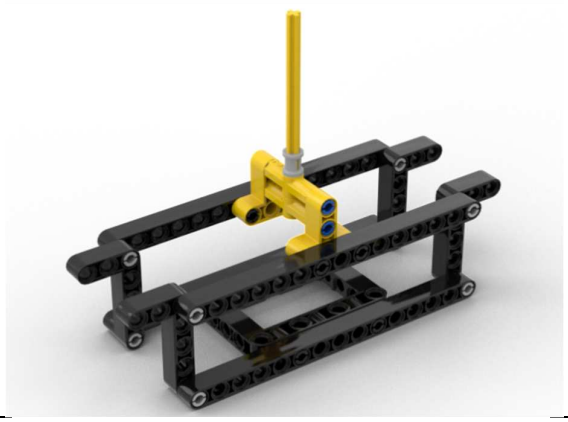
- Construction equipment will be used to aid the team in placing the required props into the building in the City Centre.
- Each team can place multiple construction equipment in the construction area.
- The construction equipment can extend into the city centre as long as the base of the construction equipment fits fully within the construction area (track of width 120mm) at start of run.
- During the robot run, the construction equipment can only move beyond the boundaries of the construction area with the action from the robot.
- During the run, teams are not allowed to move the position of the construction equipment by hand.
- Teams can only use non-motorize LEGO branded elements to build their construction equipment.

4. Game Objects, Positioning, Randomisation

1 x Gardener There is one Gardener in the white square in the Nature Reserve.	
1 x Plant Warehouse Staff There is one Plant Warehouse Staff in the red square in the Warehouse.	
1 x Solar Factory Staff There is one Solar Factory Staff in the blue square in the Factory.	
2 x Potable Water There are two potable Water blocks in any position of the three blue squares (random) in the Nature Reserve.	

1 x Non-potable Water There is one Non-potable Water block in one of the three blue squares in the Nature Reserve.	
2 x Trees There are two Trees in the two black squares in the Nature Reserve.	
2 x Empty Pot There are two Empty Pots in the Warehouse in two of the three big red squares.	
2 x Solar Panels There are two Solar Panels in the Factory in two of the three big blue rectangles.	

1 x Sun Beam There is one Sun Beam block in any one of the two yellow squares closest to the City Centre. This block will indicate the direction that the Solar Panel will need to face.	
2 x Fragile Seedling There are two fragile seedlings in the two green squares within the Nature Reserve.	
2 x Yellow Flower Plant There are two Yellow Flower Plant in the two yellow squares within the Nature Reserve.	
2 x Red Flower Plant There are two Red Flower Plants in the two red squares within the Nature Reserve.	

2 x Hanging Pots There are two Hanging Pots in the two red rectangles in the Warehouse.	
1 x Charging Switch There is one Charging Switch which will be placed in the rectangle above the Charging Station. This will be secured onto the playmat using double sided tape, with the starting position towards the red line.	
2 x Empty Building There are 2 empty buildings within the City Centre in the green rectangles. This will be secured onto the playmat using double sided tape.	

<u>One start area</u>

There is only one start area on the field which is the Charging Station. Before the start of the run, the robot must fit completely in this start area. The surrounding line is not included in the start area. Cables must be included in these dimensions. After the Robot has started, the dimensions of the robot are not restricted to the size of the Charging Station.

5. Robot Missions

For a better understanding, the missions will be explained in multiple sections.
The team can decide in which order they will do the missions.

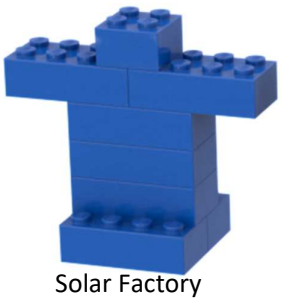
Scoring for each mission will be:
Final State (scoring is done when the robot attempt ends)

5.1 Public Shuttle Service

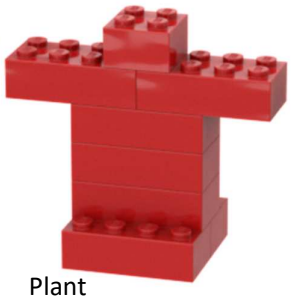
Cars are inefficient in many ways. In this mission, the robot will act as a public shuttle service.

There is always one Gardener (White), one Plant Warehouse Staff (Red) and one Solar Factory Staff (Blue) placed around the playfield. The Robot is to bring the Gardener, Plant Warehouse Staff and Solar Factory Staff to the newly developed City Centre. Ensure that they are travelling safely and remain upright when they have reached their destination.

Full points are awarded if the Staffs are completely inside the City Centre and remain upright in the City Centre.



Solar Factory Staff



Plant Warehouse Staff

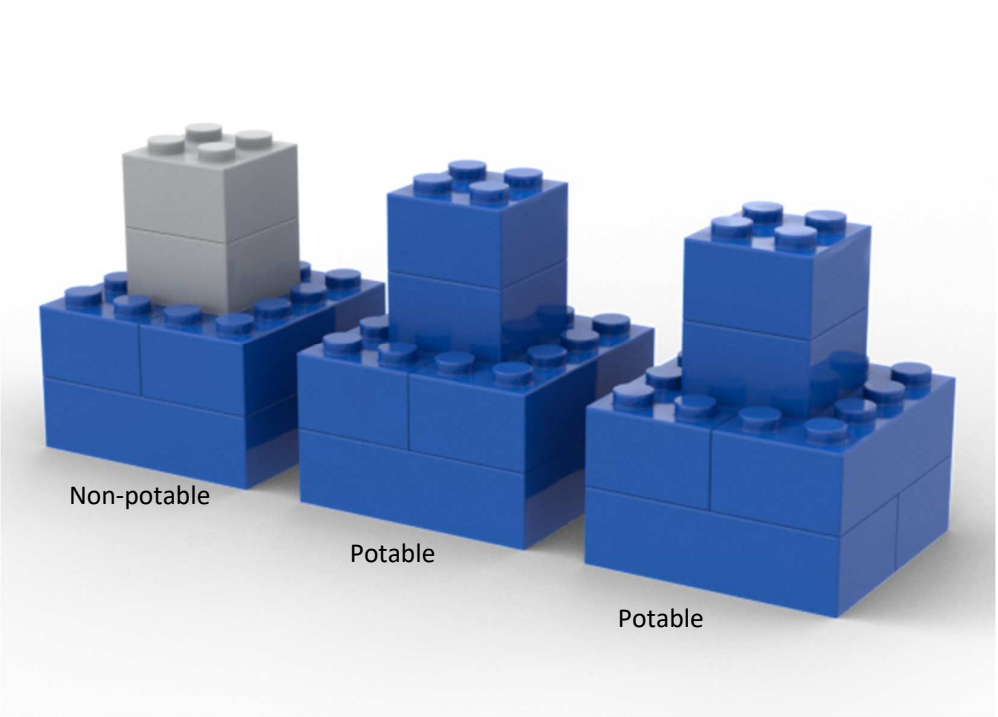
Gardener

5.2 Water Management

In this city, there is a Water Tank installed along the river. The indicators atop the Tanks will tell us if the water is Potable (Blue Indicator) or Non-potable (Gray Indicator). There are always two Potable and one Non-potable Water blocks. These are placed in random positions in the three blue squares in the Nature Reserve.

The robot should identify the Potable Water from the Non-potable Water blocks. The Potable Water are to be transported to the city centre.

Full points are awarded if only the Potable Water blocks are completely inside the City Centre. Negative scores are awarded when the Non-Potable Water block is partially or completely inside City Centre.

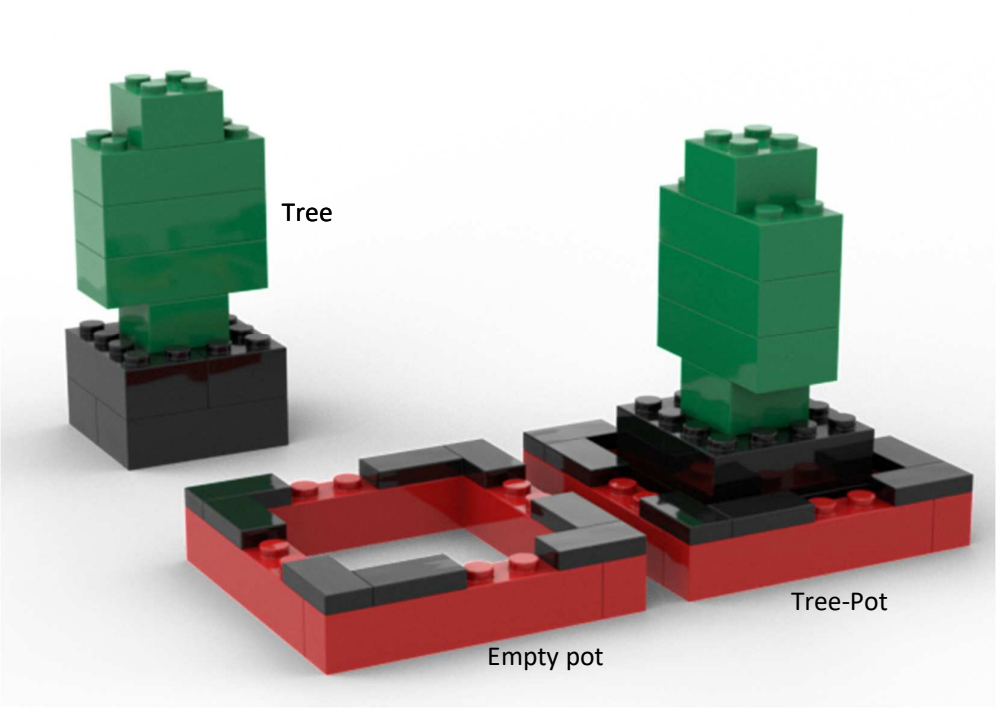


5.3 Tree Management

Construction work can be damaging to the natural environment. Instead of destroying local flora, a sustainable development may involve moving trees away during construction and replanting them when the development is complete. In this city, native trees have been moved to the Nature Reserve while construction is underway.

There are only two empty pots randomly placed on three red squares in the Plant Warehouse. The robot must transport the Trees and placed them into the empty pots. The combination of the trees in the empty pots are called Tree-Pots. These Tree-Pots are to be transported into the City Centre.

Full points are awarded if the Tree-Pots are completely in the City Centre.



5.4 City Management

Use of renewable energy sources and adding greenery are two traits of sustainable buildings.

There will be two solar panels randomly placed on any two of the three blue squares in the factory area. Your task is to collect the Solar Panels from the Solar Factory and place is at the top level of the building in the City Centre. There will be one Sun Beam randomly placed in the yellow box near the City Centre. The Solar Panel must be placed such that it is facing the Sun Beam. The Solar Panel will be considered correctly placed if the blue beams of the Solar Panel are facing the Sun Beam.

Your next task is to harvest Fragile Seedlings and Red and Yellow Flower Plants from the Nature Reserve to beautify the Building in the City Centre.

- Fragile Seedlings cannot withstand harsh conditions. As such, they should only be planted on the ground floor of the building.
- Beautify the various levels of the Building with greenery. Your task is to decorate the middle level of the Building with Red Flower Plants.
- Vertical gardening can help to beautify the building even with limited spaces. Your task is to place both the Yellow Flower Plants and Hanging Pots on any sides of the Building. The two Hanging Pots can be found in the Plant Warehouse.

To aid the robot in completing this mission, teams may install Construction Equipment in the Construction Zone.

- Construction Equipment is a mechanism created by the team to help load the flowers and the Solar Panel onto the Buildings.
- Construction Equipment cannot be motorized.
- Teams can program the robot to gather all the Fragile Seedlings, Solar Panel, Red Flower Plants and Yellow Flower Plants and the Hanging Pots to the Loading Bay.
    - Other props that were brought into the Loading Bay cannot be physically manipulated by hand by the teams.
- Once the robot has completely stopped in the Loading Bay, team members are allowed to place the items, by hand, onto their Construction Equipment.
    - For the Yellow Flower Plants and Hanging Pots, teams are not allowed to combine them by hand in the Loading Bay. They will be loaded onto the Construction Equipment in whatever state (combined or separated) the robot brought them into the Loading Bay.
- Once the loading is completed, the robot can resume their robot run (with a different program) and load the props onto the Building in the City Centre with only the aid of the Construction Equipment.
- When attempting this mission, robots are not allowed to load these items directly on the building without the use of the Construction Equipment.
- During the robot run, the Construction Equipment can only expand or move beyond the boundaries of the construction area with the help from the Robot.

- Bonus points will be awarded to teams if they return all their Construction Equipment back to the Warehouse area after use.

Points are awarded if:

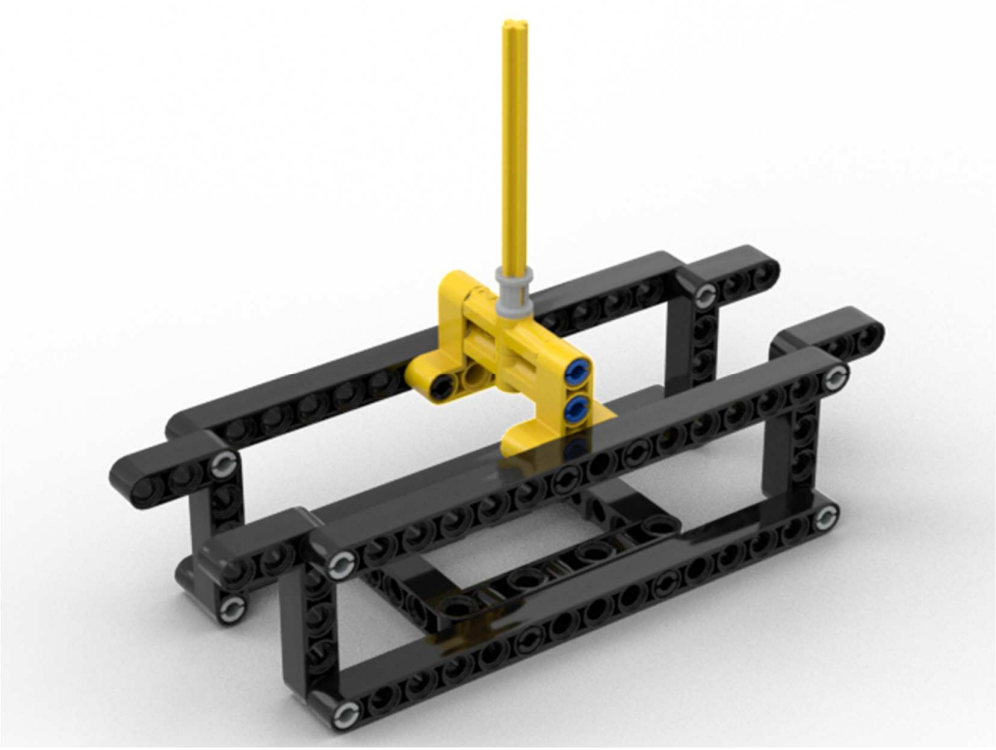
- Solar Panels are on the top level of the building in the City Centre and/or facing the Sun Beam.
- Fragile Seedings are placed in ground floor of the Building in City Centre.
- Red Flower Plants are in middle level of Building in the City Centre.
- Yellow Flower Plants are in the Hanging Pots on Plant Wall (sides) of Building in the City Centre.
- Construction Equipment is (are) in the Warehouse.

5.5 Return to charging station

Electric Vehicle usage results in lower pollution levels. When charged with electricity produced by sustainable means, these vehicles are more eco-friendly to run than Internal Combustion Engine (ICE) Vehicles.

Once you have completed your tasks, park your robot back at the Charging Station. Activate the Switch to the Green Charging Indicator to begin charging with the energy generated by the Solar Panel the robot has installed. Switch is considered turned on when it's towards the green line.

Full points are awarded if the robot is completely inside the Charging Station and switch is activated, with at least 1 Solar Panel installed (in any direction).



5.6 Get bonus points

Bonus points will be awarded for not moving or damaging the Building in City Centre. These points will only be given if there are other points scored in the previous sections.

6. Scoring

Definitions for the scoring

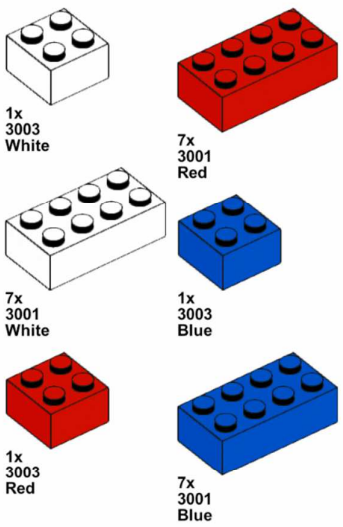
"Completely" means that the game object is only touching the corresponding area (not including the black lines).		
Tasks	**Each**	**Total**
1. Public Shuttle Service		
Staff (Blue, Red and White) standing upright and completely in City Centre	**5**	**15**
2. Water Management		
Potable water extracted from river	5	10
Potable water extracted from river and in the City Centre	**10**	**20**
Non-potable water in the City Centre	-20	-20
3. Tree Management		
Only Tree in City Centre	5	10
Tree in Pot but not in the City Centre	10	20
Tree-Pot in the City Centre	**15**	**30**
4.1 City Management – Solar Panel		
Solar Panel in the City Centre but not on the building	5	10
Solar Panel on the top level of the building in the City Centre but not facing Sun Beam	15	30
Solar Panel on the top level of the building in the City Centre and facing Sun Beam	**20**	**40**
4.2 City Management – Fragile Seedling		
Fragile Seedling placed in City Centre but not in building /or in Building but not on ground floor	5	10
Fragile Seedling placed in ground floor of building in the City Centre	**10**	**20**
4.3 City Management – Red and Yellow Flower Plants		
Yellow Flower Plants in the City Centre but not in Hanging Pot	5	20
Yellow Flower Plants in Hanging Pot but not in the City Centre or Yellow Flower Plants in Building but not in Hanging Pot on Building	10	20
Yellow Flower Plants in Hanging Pot on the Plant Wall of building in the City Centre	**20**	**40**
Red Flower Plant in the City Centre	5	10
Red Flower Plant in mid-tier of Building in the City Centre	**10**	**20**
4.4 City Management – Construction Equipment		
All Construction Equipment is fully in the Warehouse (Only award if other points are scored in the City Management)		**15**
5. Charging Station		
Projection of the Robot is fully in the charging station but switch is Off		5
Projection of the Robot is fully in the charging station and Switch is On but no Solar Panel is installed		5
Projection of the Robot is fully in the charging station and switch is On, with at least one Solar Panel installed in any direction		**10**
6. Get Bonus Points (only if points were given in the previous sections)		
City Centre is not moved or damaged		**10**
Maximum Score		**220**

7. Scoring Interpretation

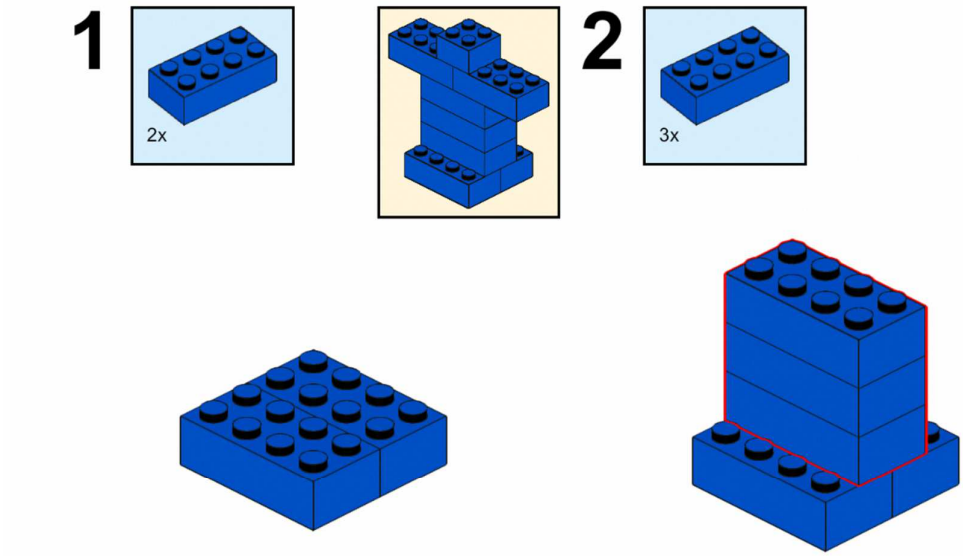
- Scoring Interpretation will be released at a later date -

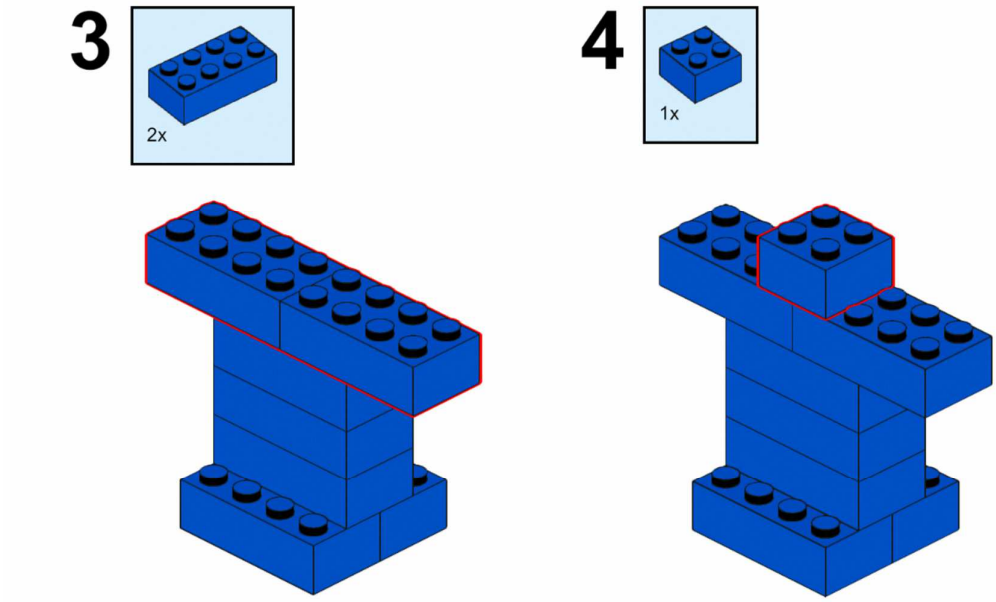
8. Assembly of Game Objects

8.1 Public Shuttle Service

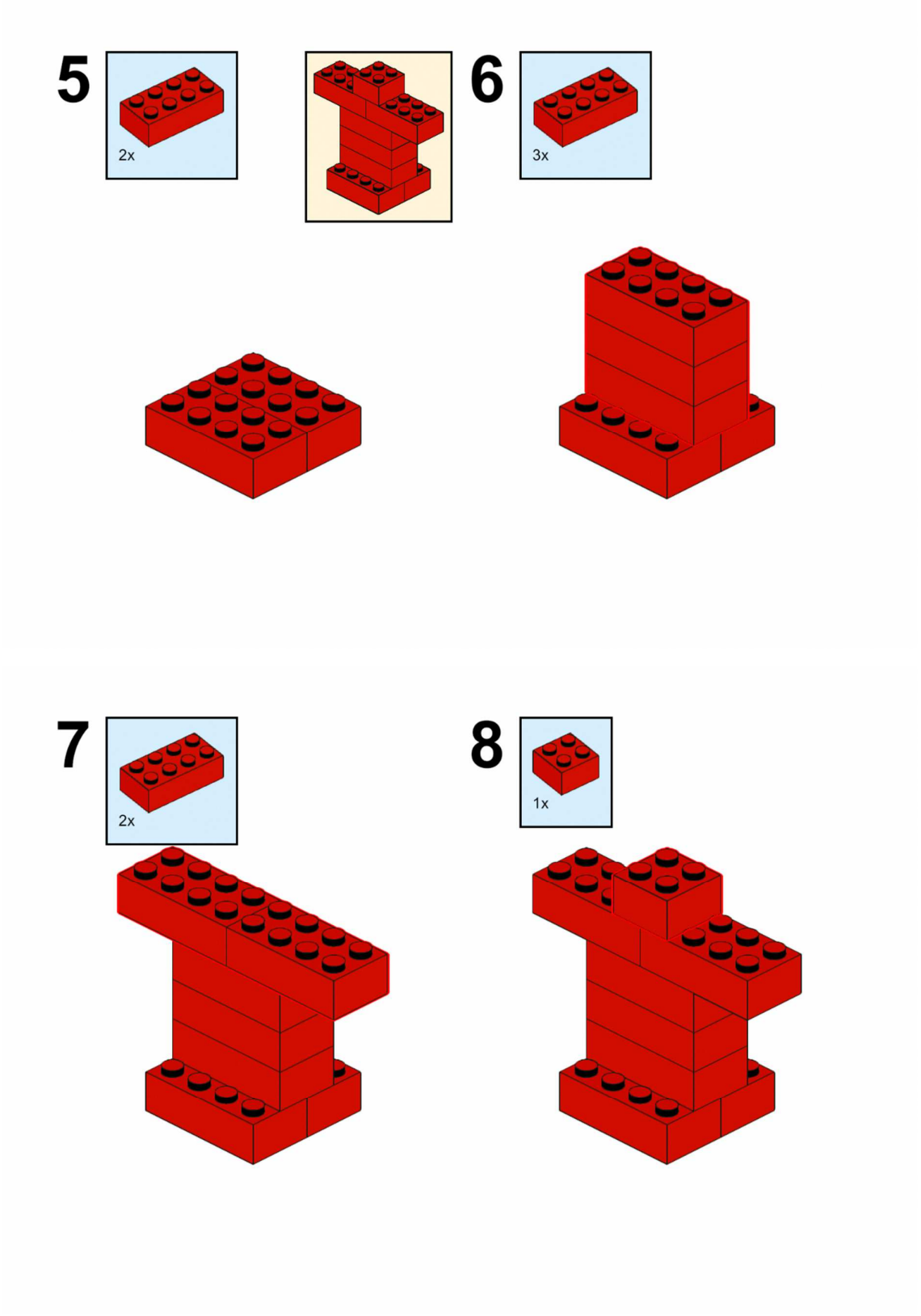


8.1A Solar Factory Staff

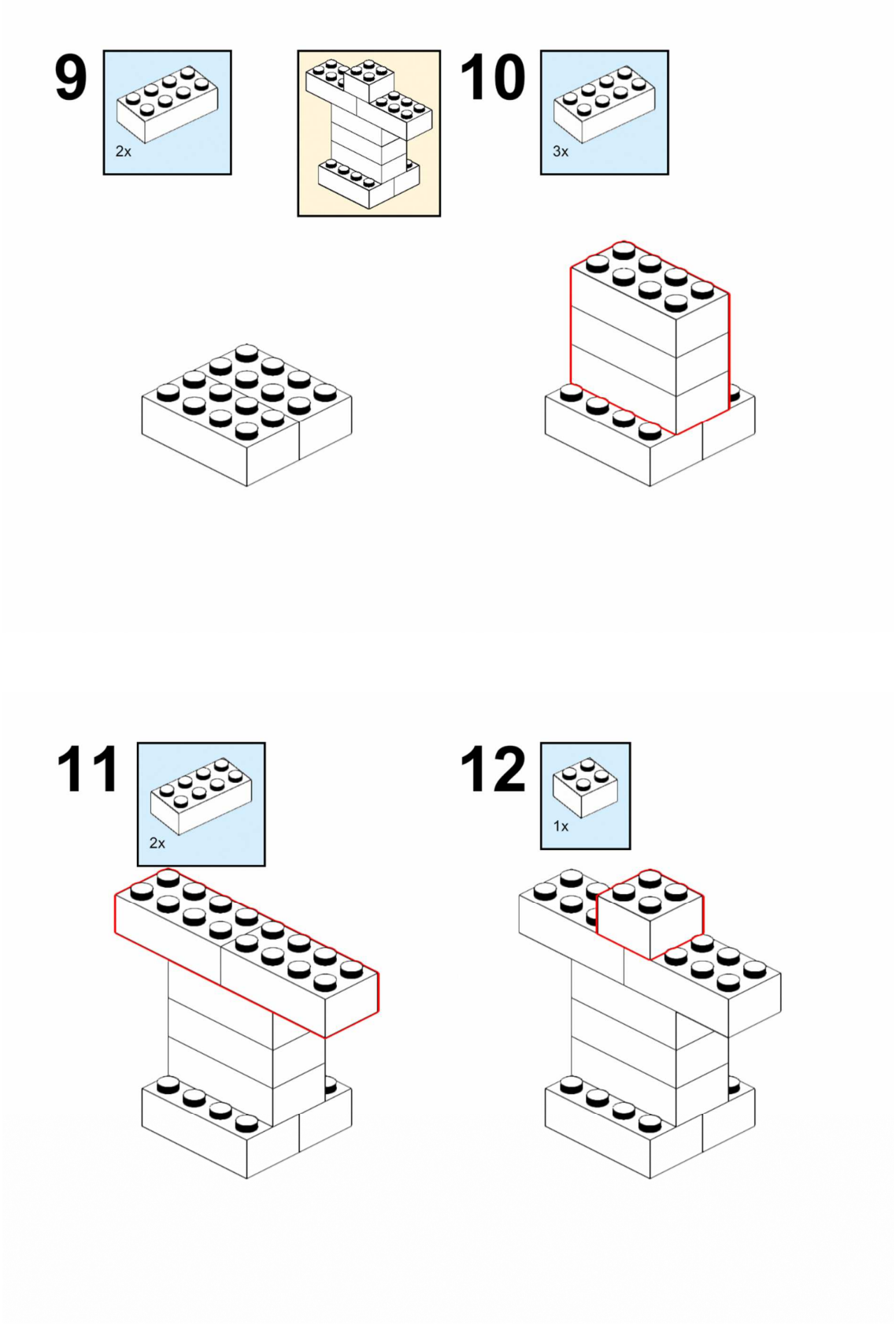




8.1B Plant Warehouse Staff



8.1C Gardener



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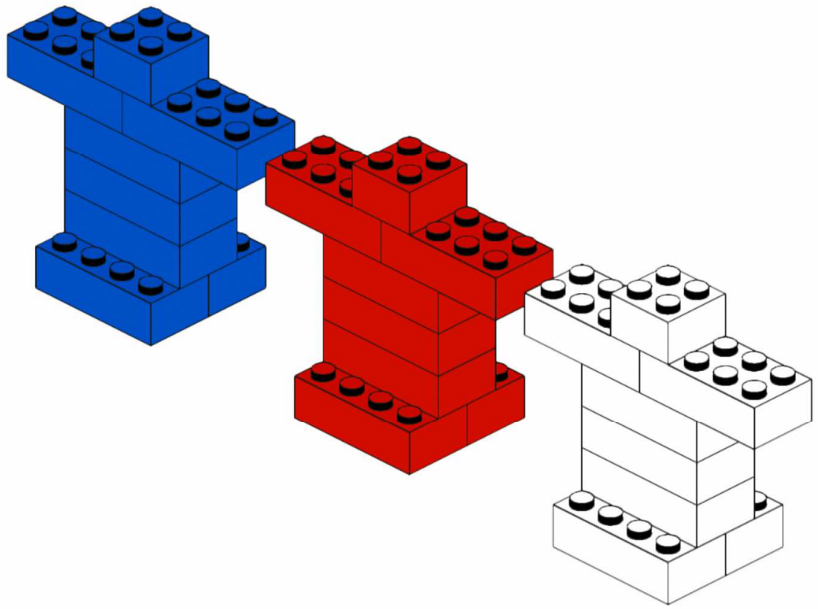

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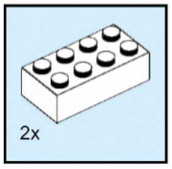

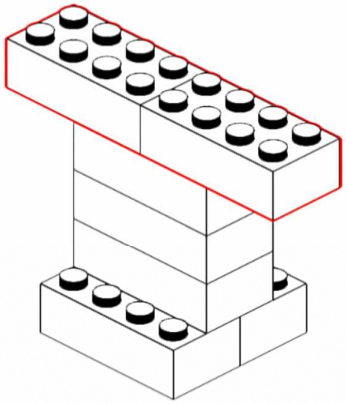

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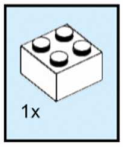
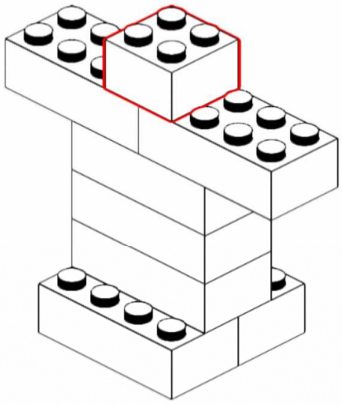
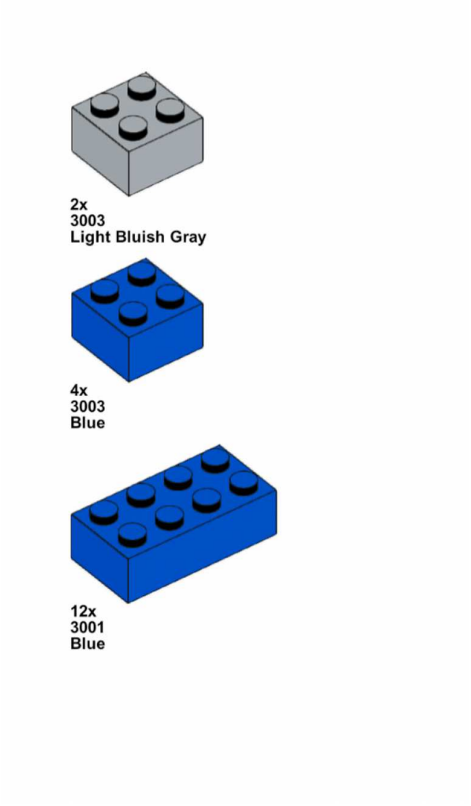
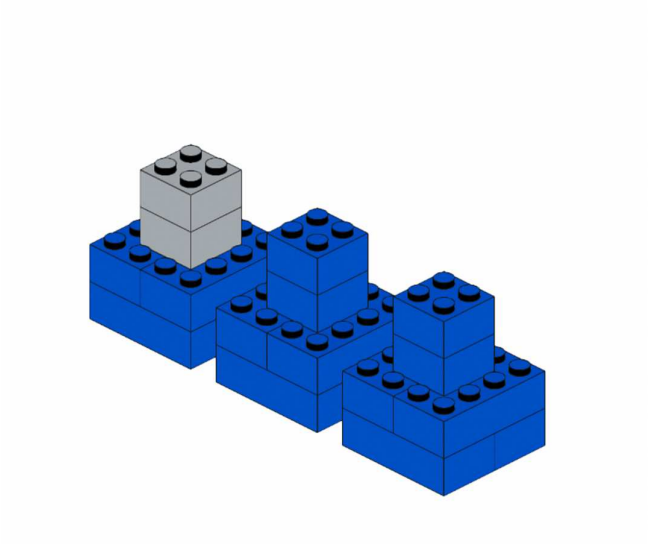


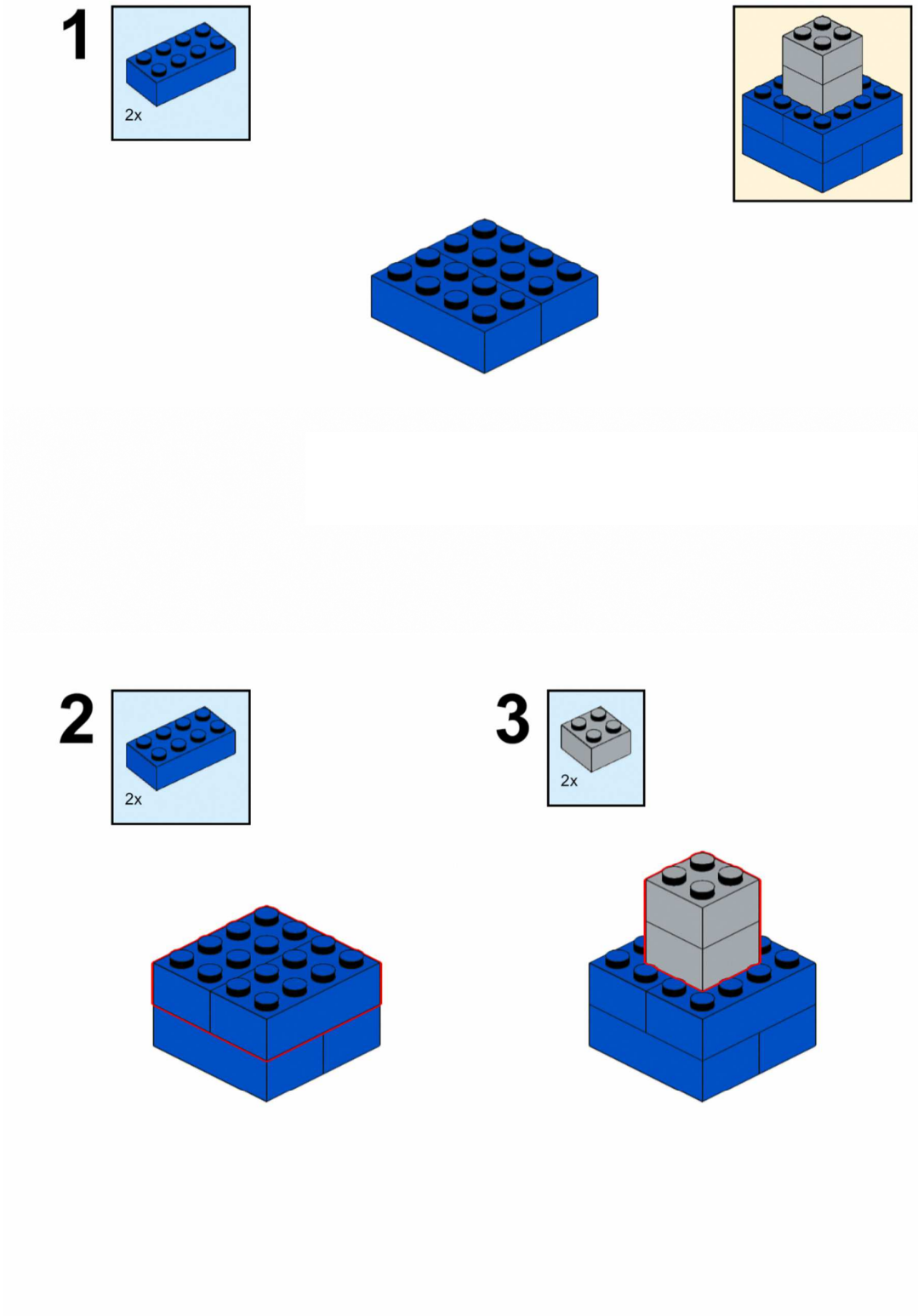


8.2 Water Management

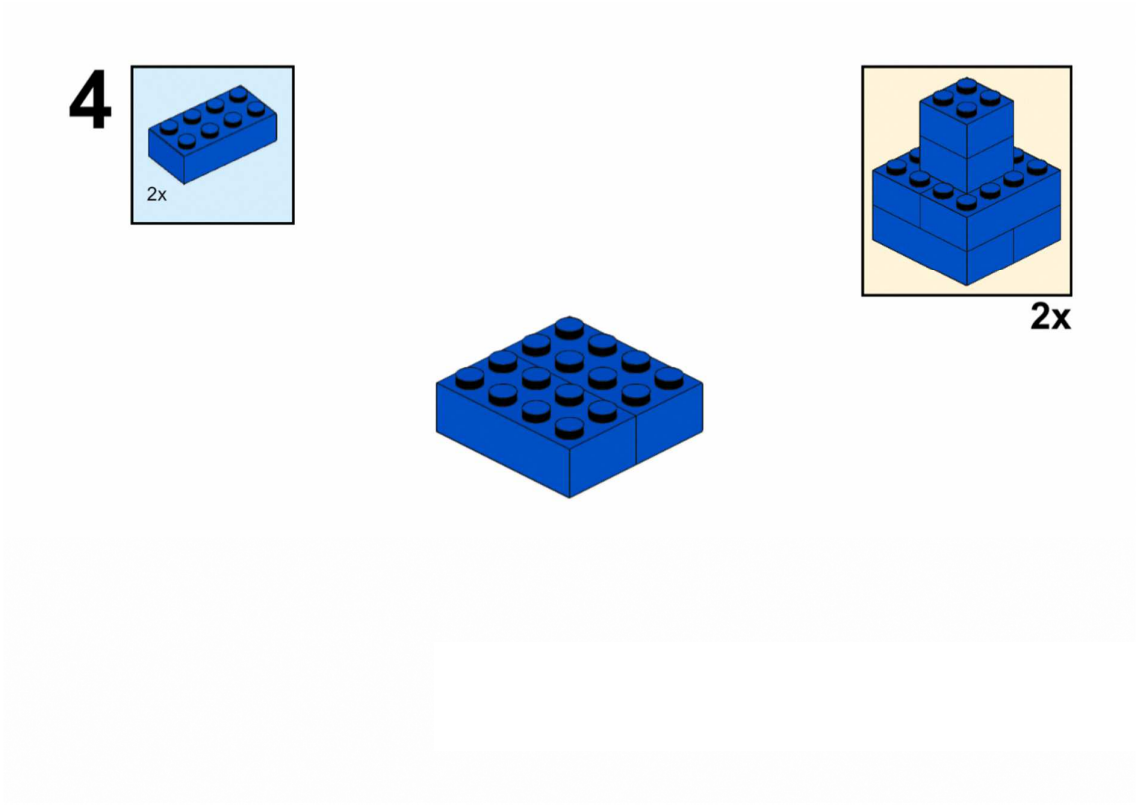




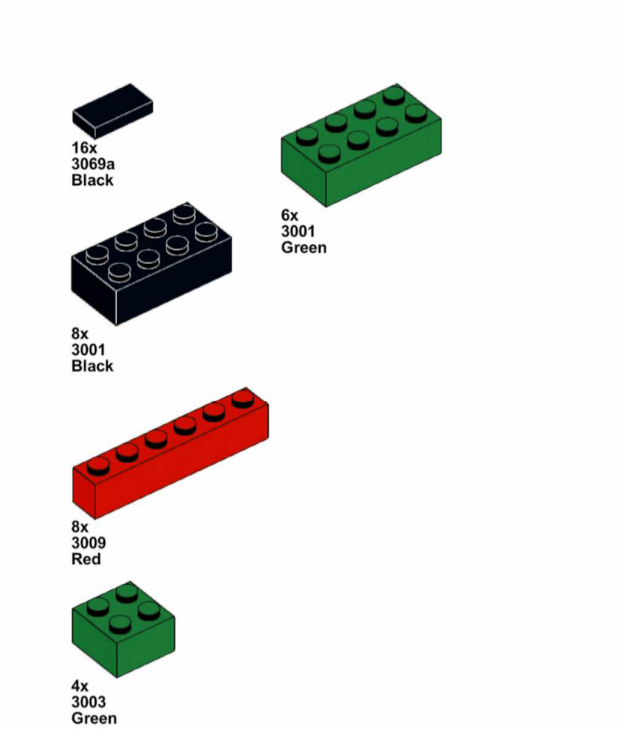
8.2A Non-potable Water

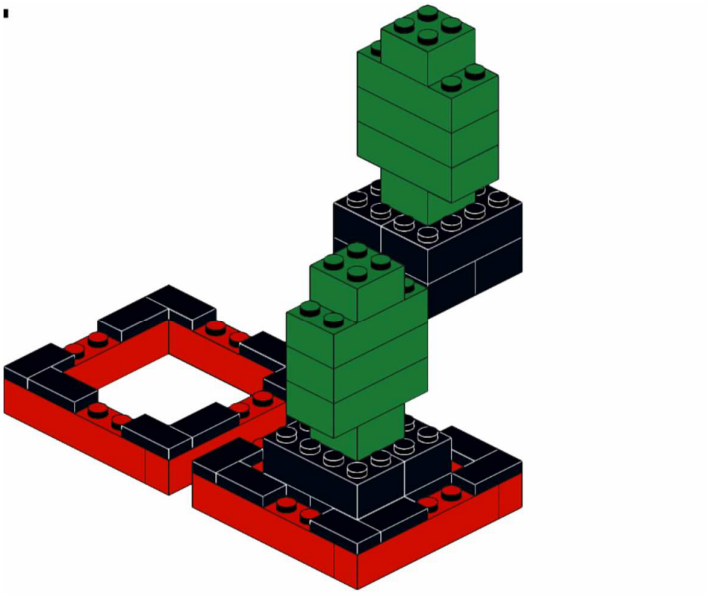


8.2B Potable Water

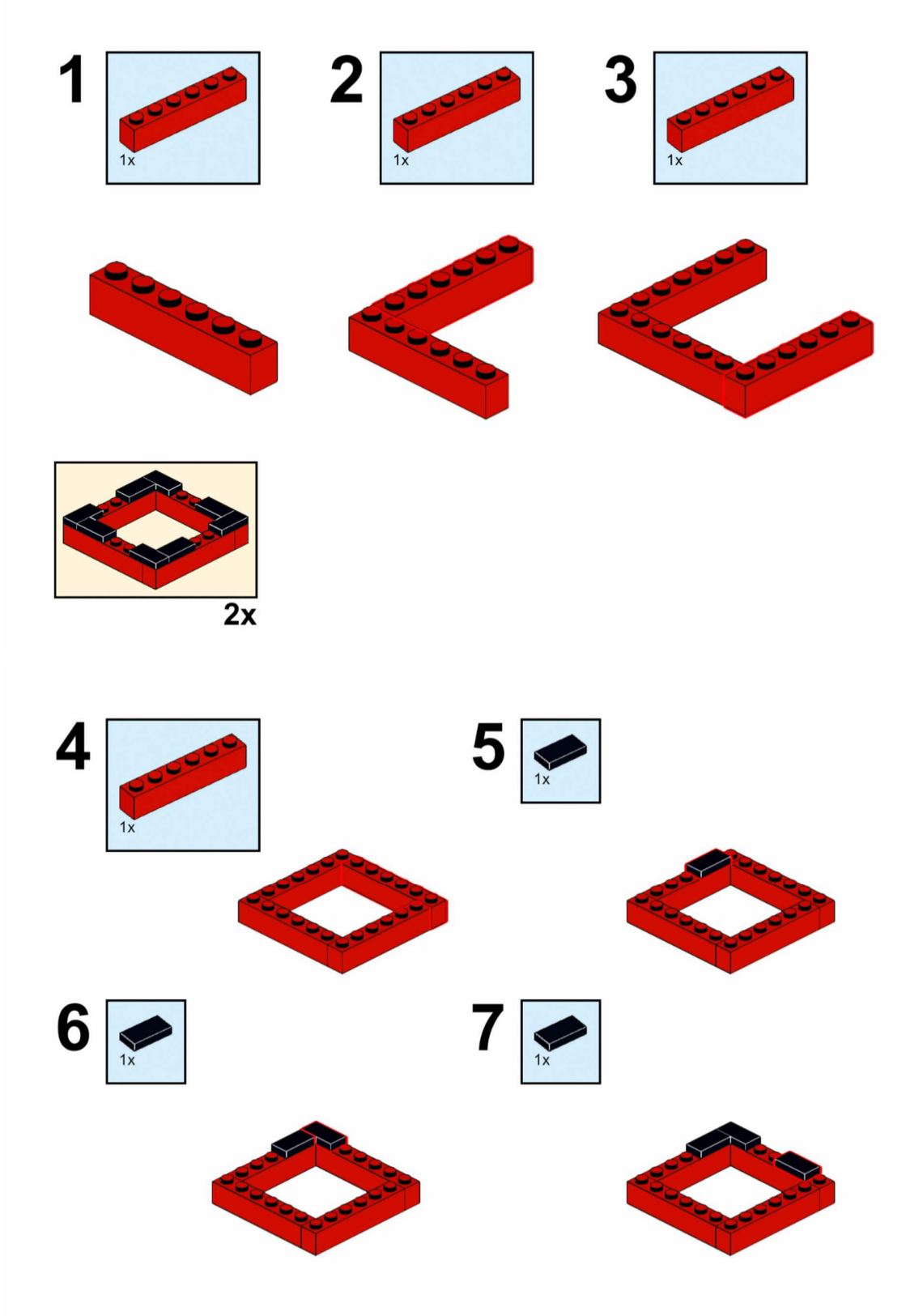


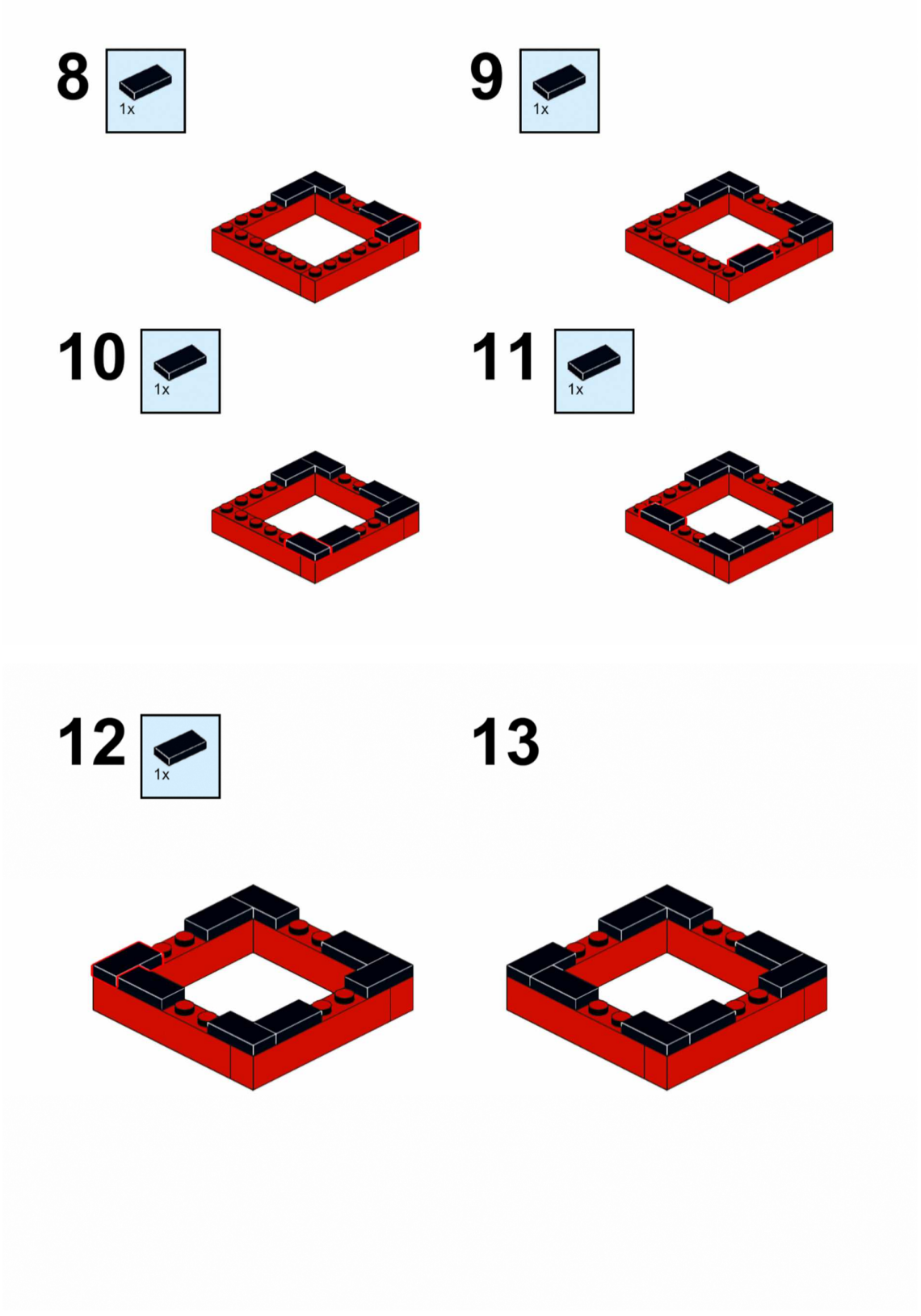
8.3 Tree Management



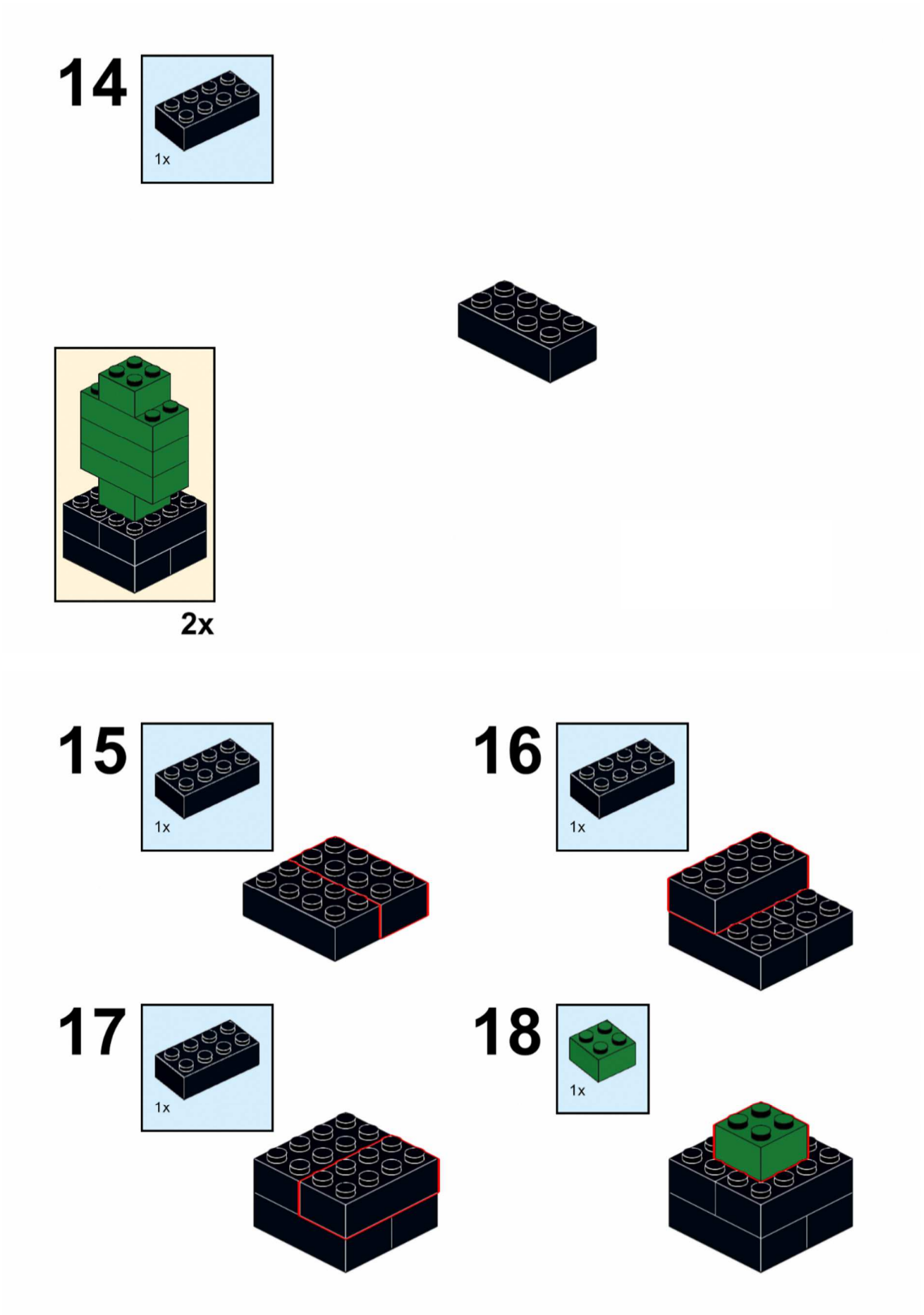


8.3A Empty Pot




8
1x
9
1x
10
1x
11
1x
12
1x
13

8.3B Plant



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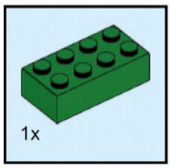

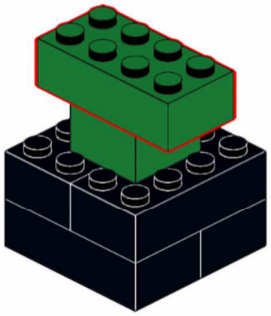

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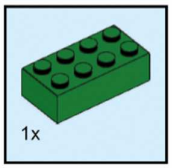

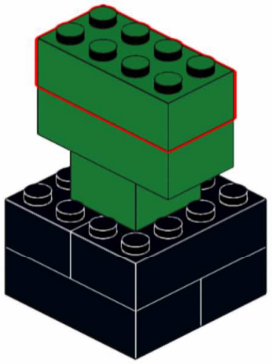

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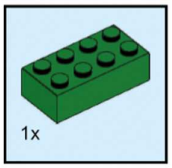
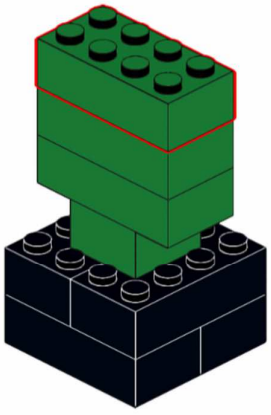
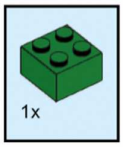
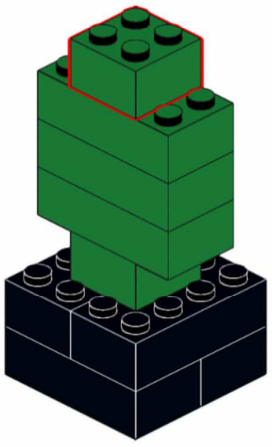




22





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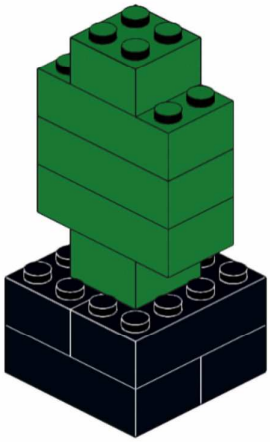
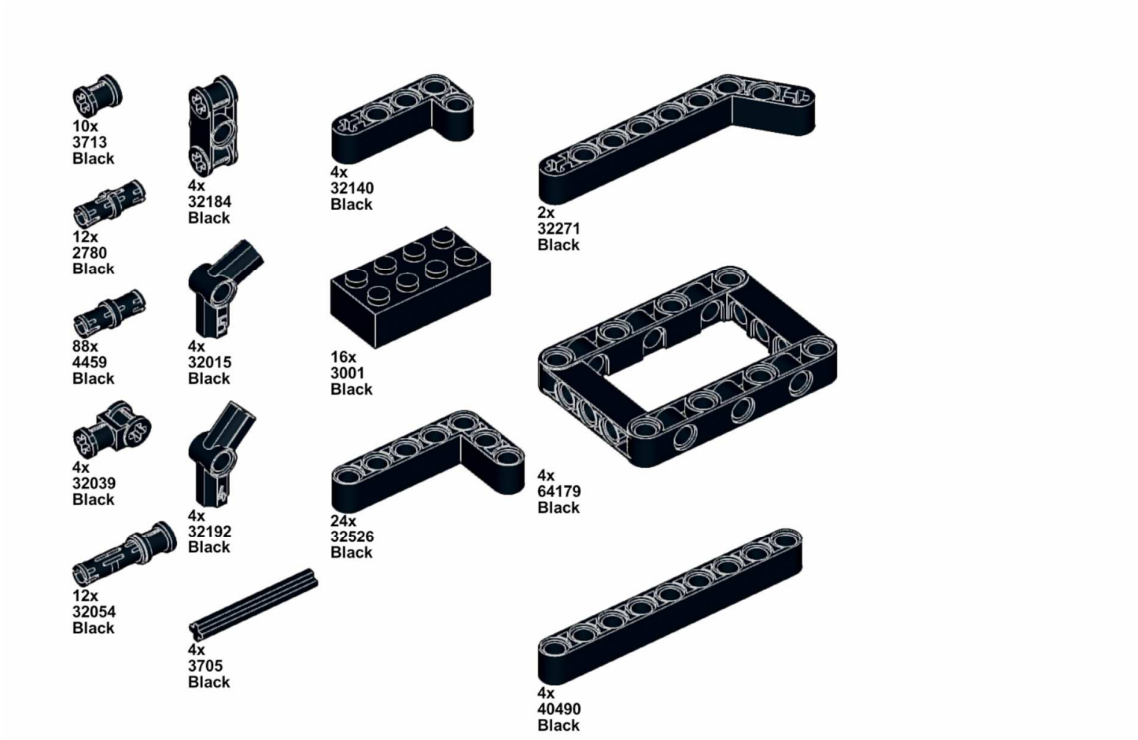
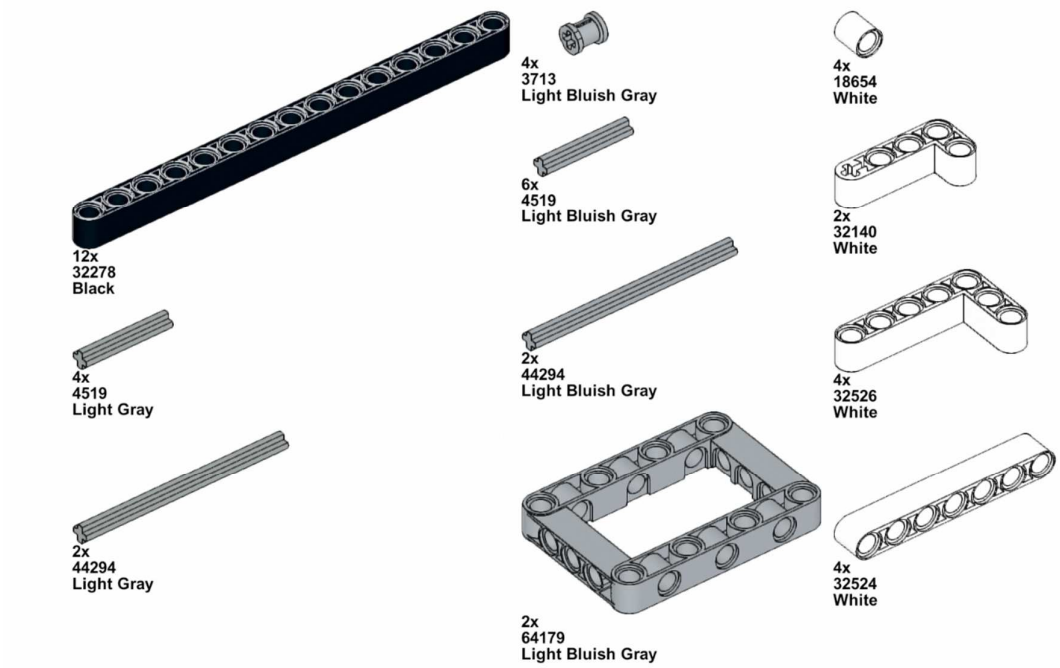
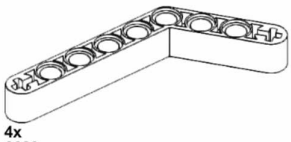


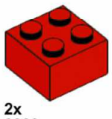
8.4 City Management



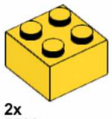




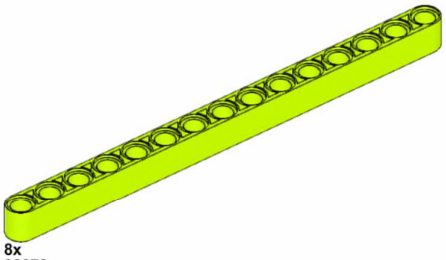
4x
6629
White



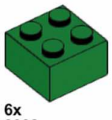
2x
3003
Red



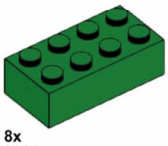
2x
3003
Yellow



8x
32278
Lime



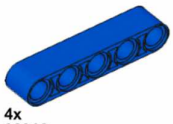
6x
3003
Green



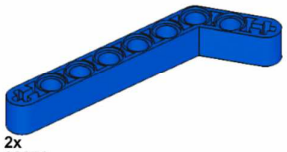
8x
3001
Green

4x
43093
Blue

20x
6558
Blue

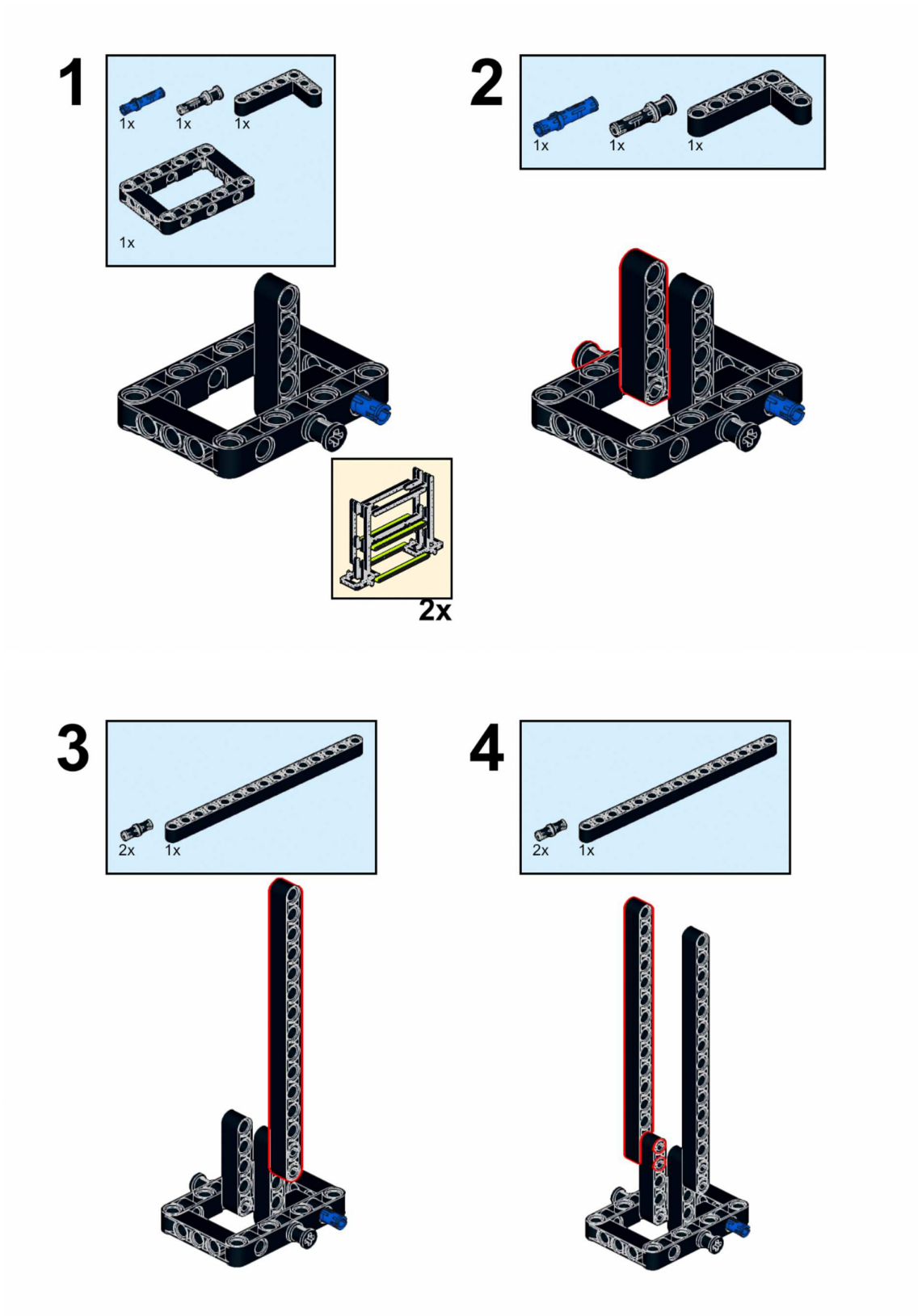


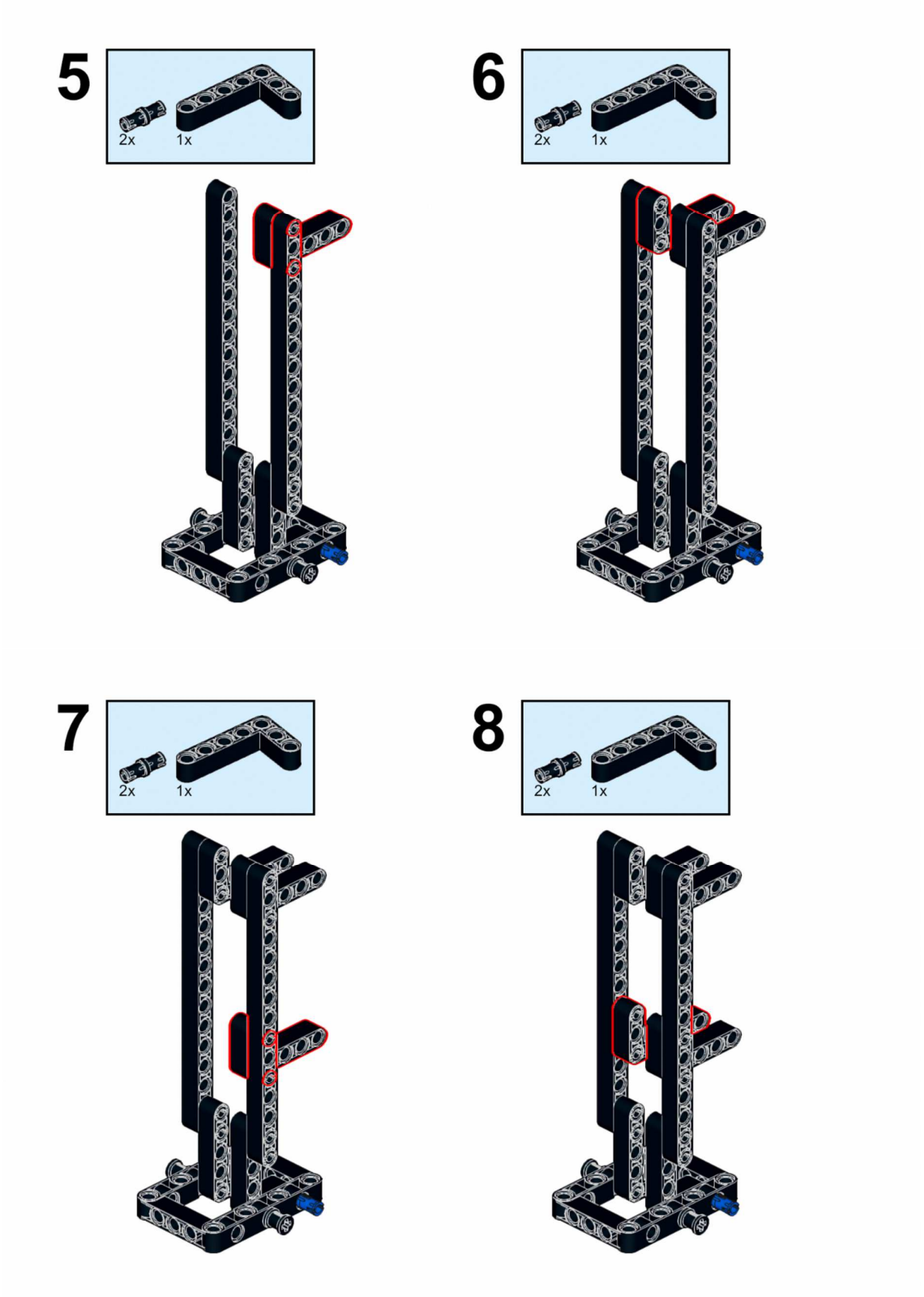
4x
32316
Blue

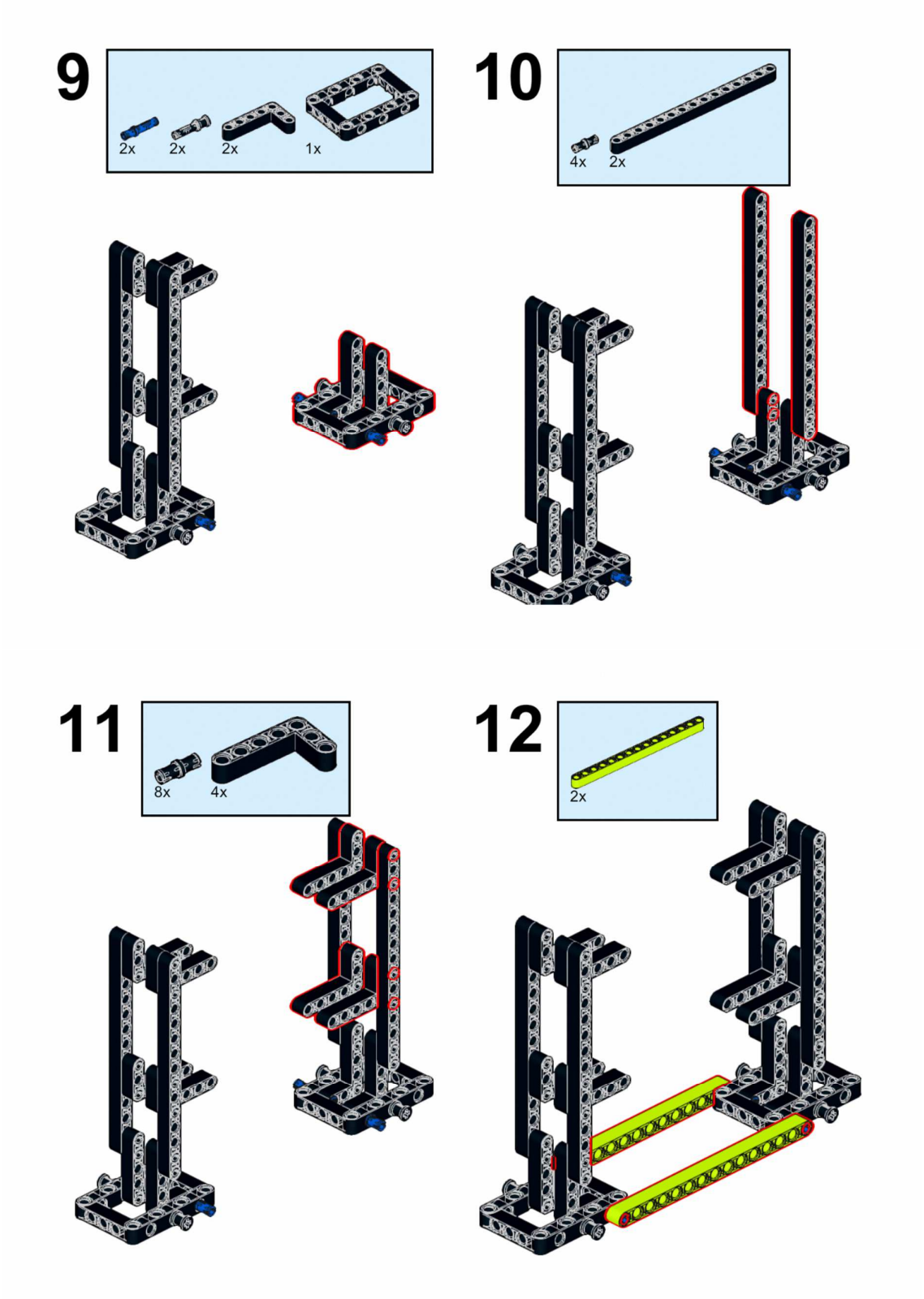


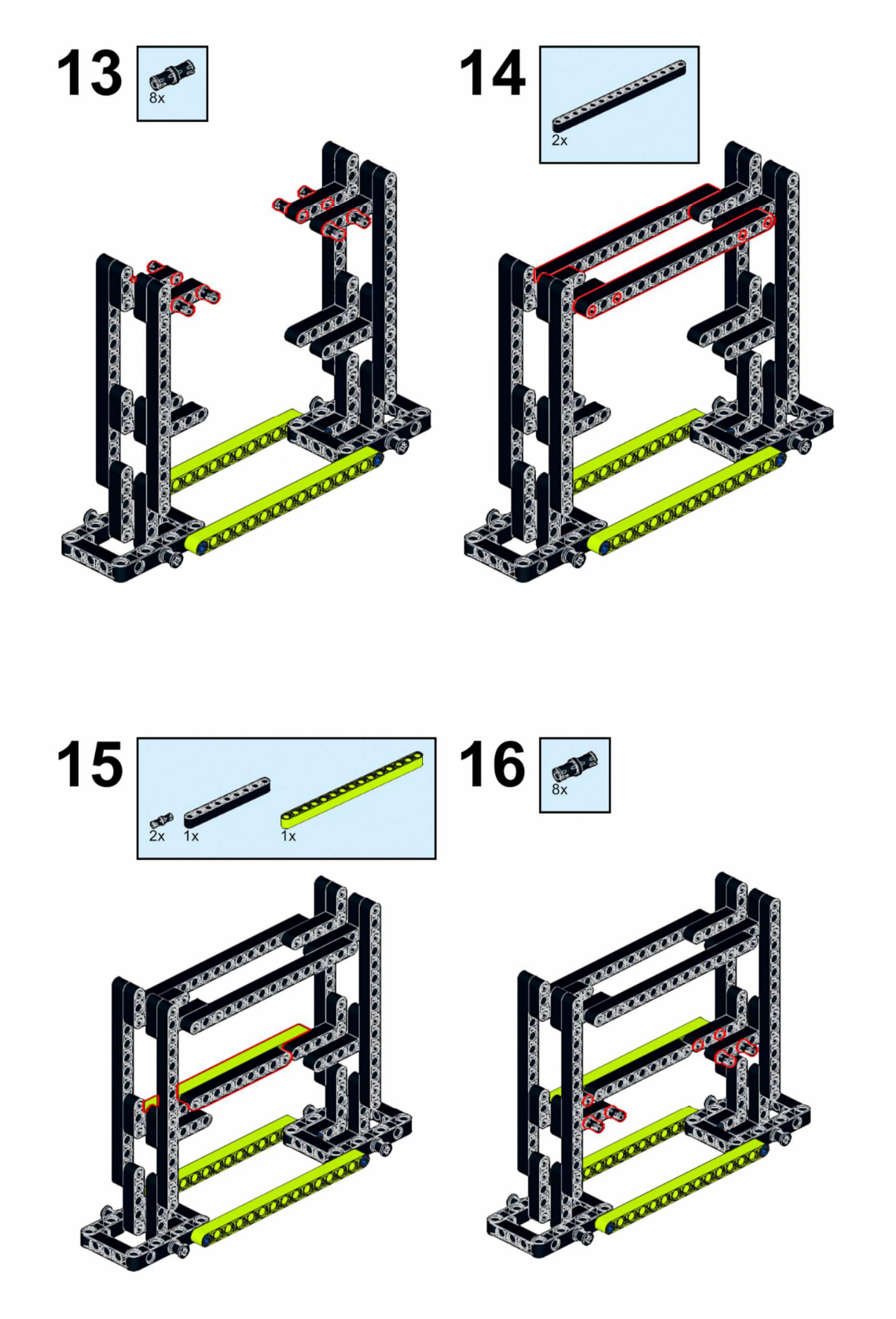
2x
32271
Blue

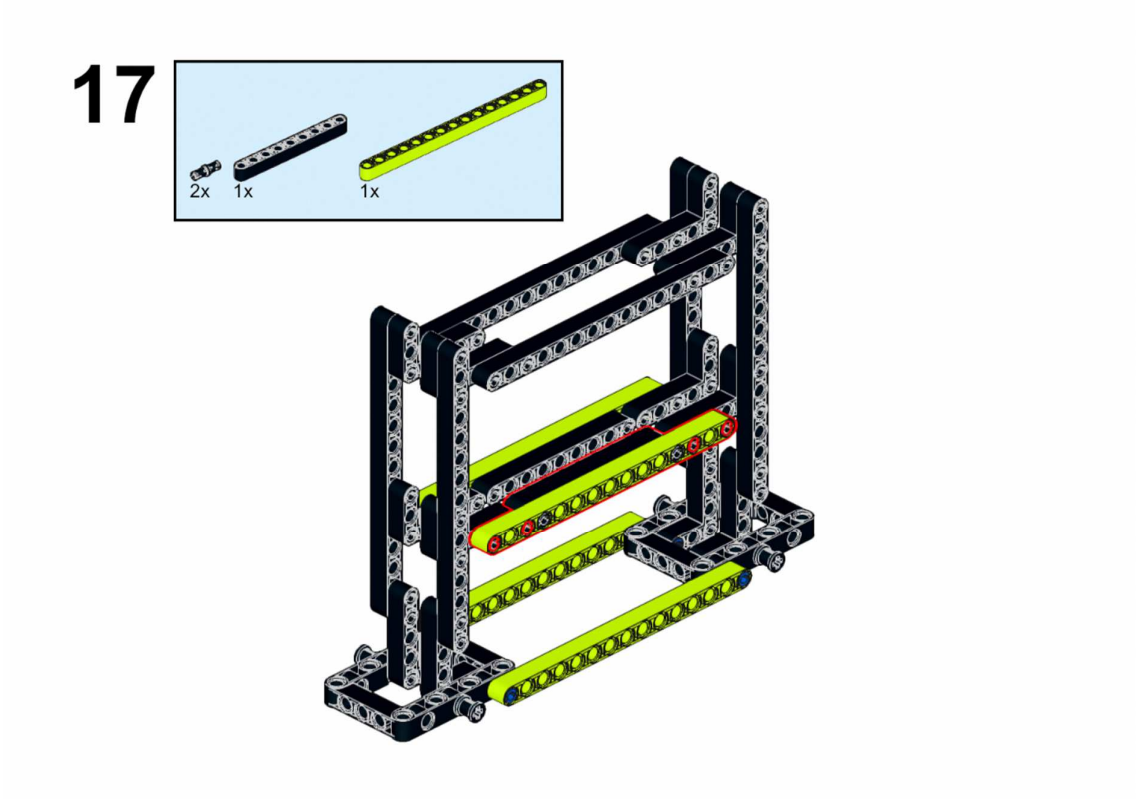
8.4A Building



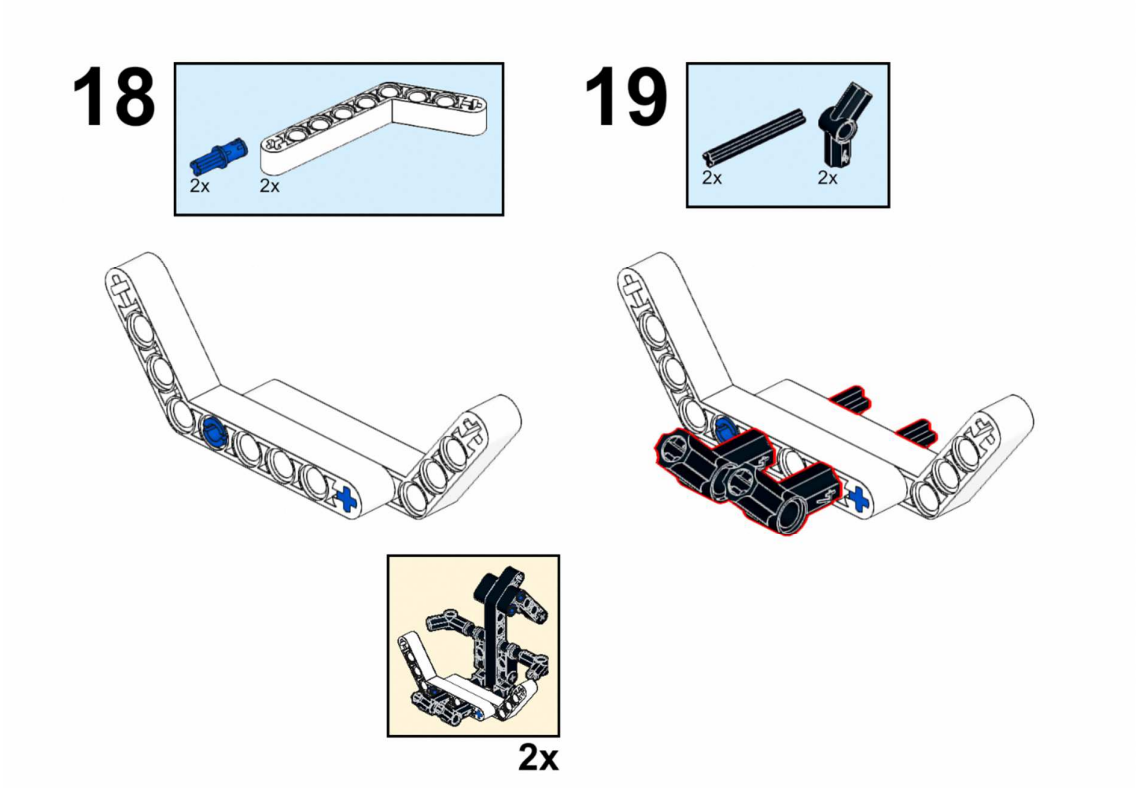

5
2x
1x
6
2x
1x
7
2x
1x
8
2x
1x

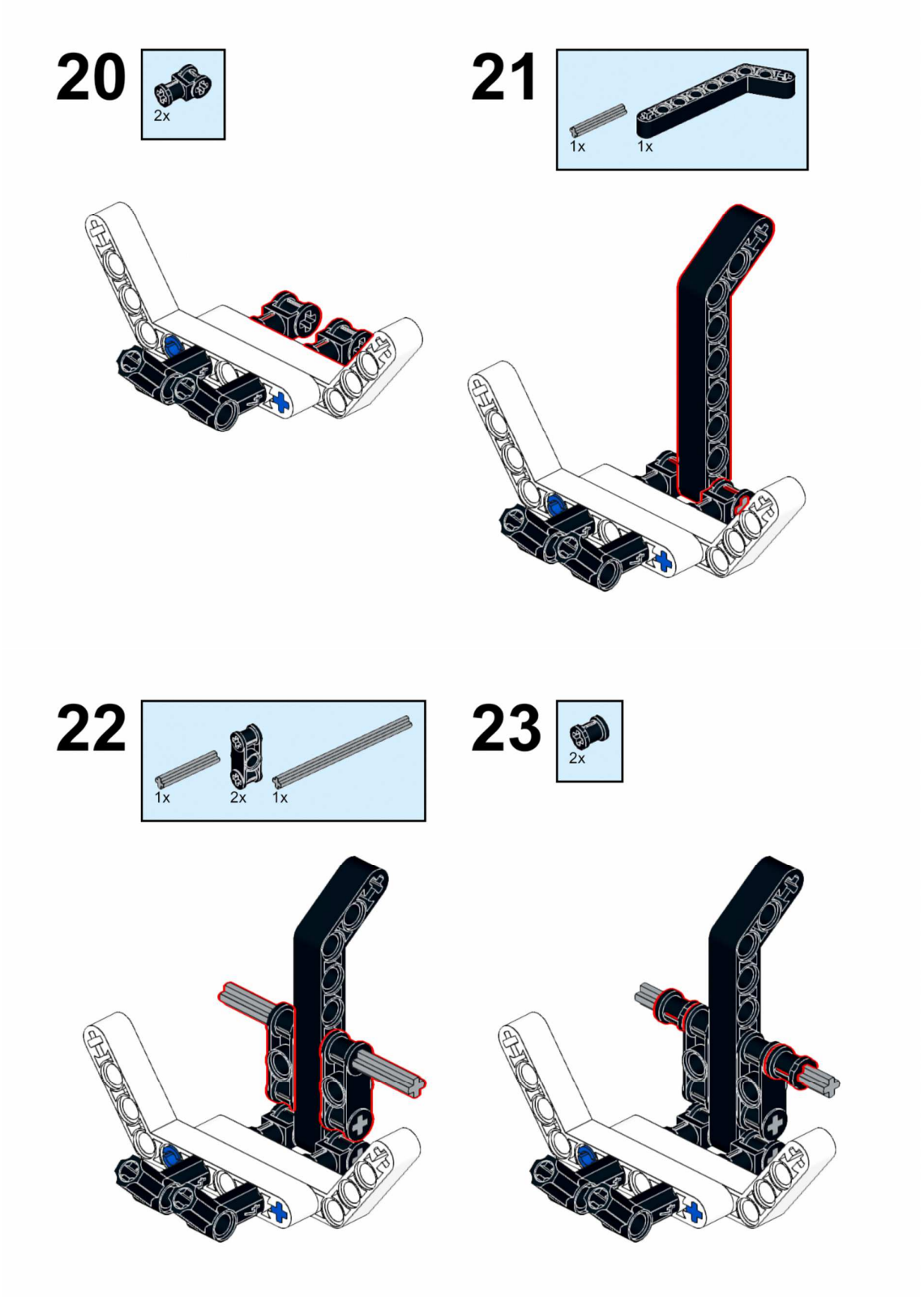

9
2x
2x
2x
1x
10
4x
2x
11
8x
4x
12
2x

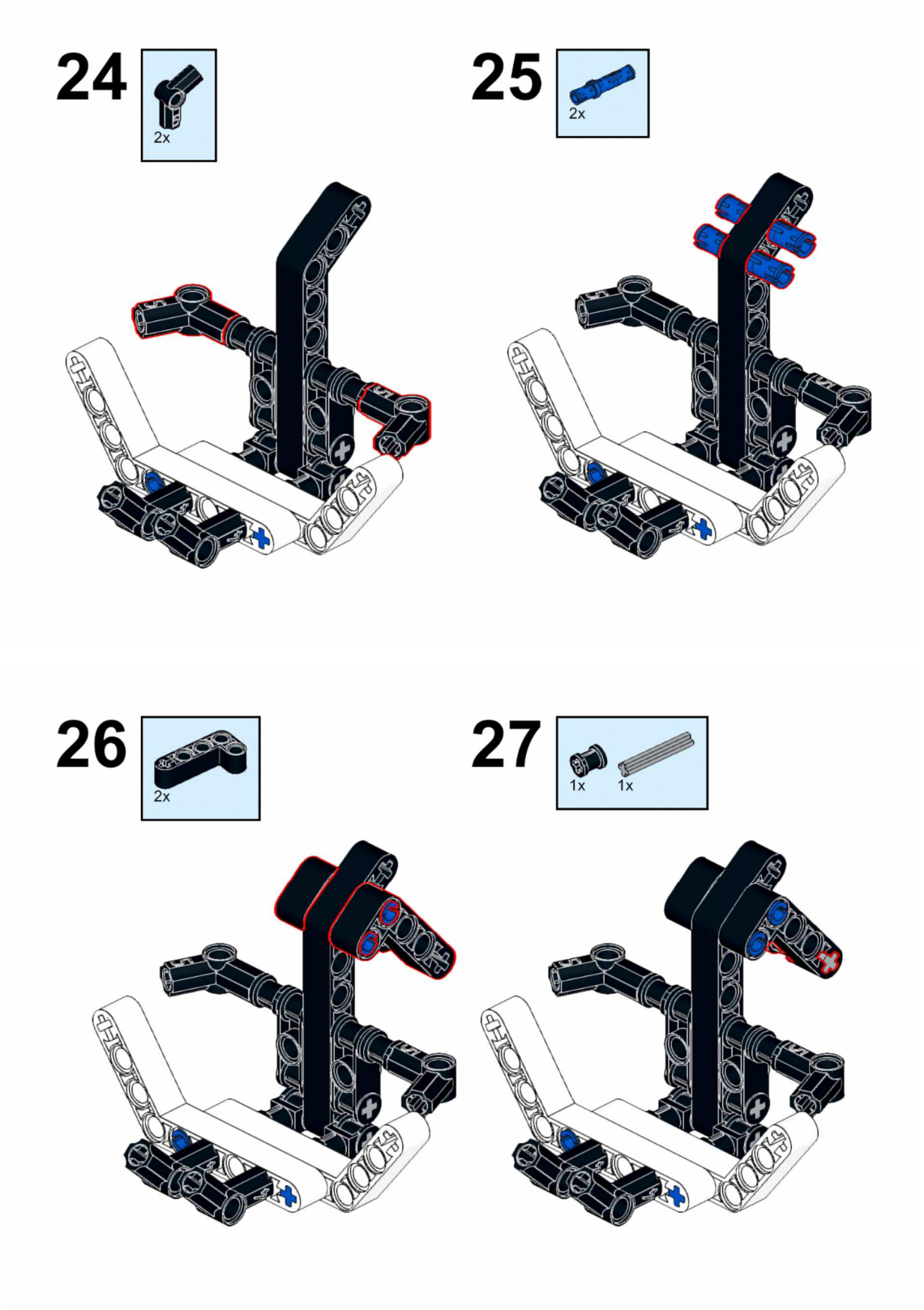

13
8x
14
2x
15
2x
1x
1x
16
8x



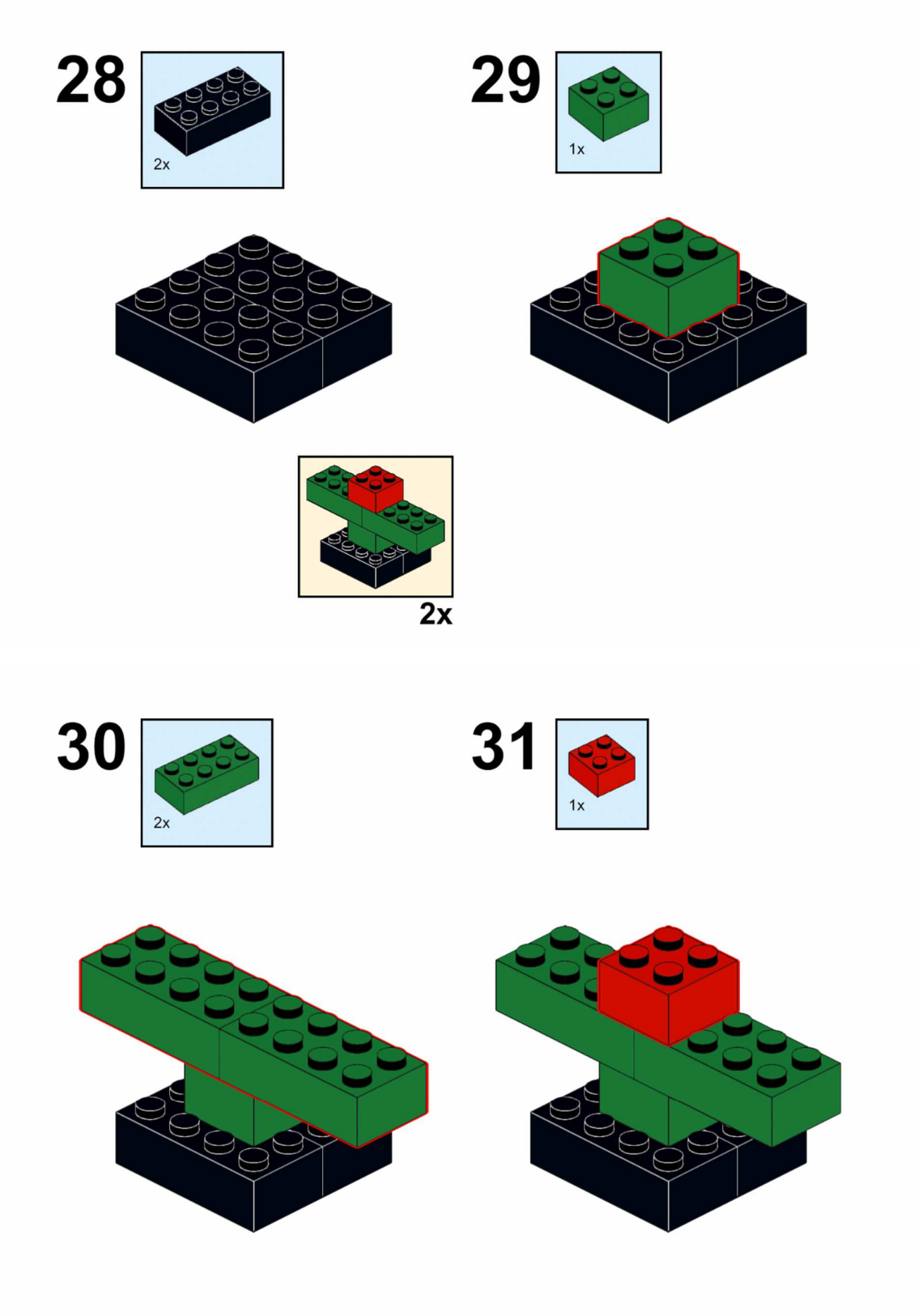
8.4B Hanging Pot

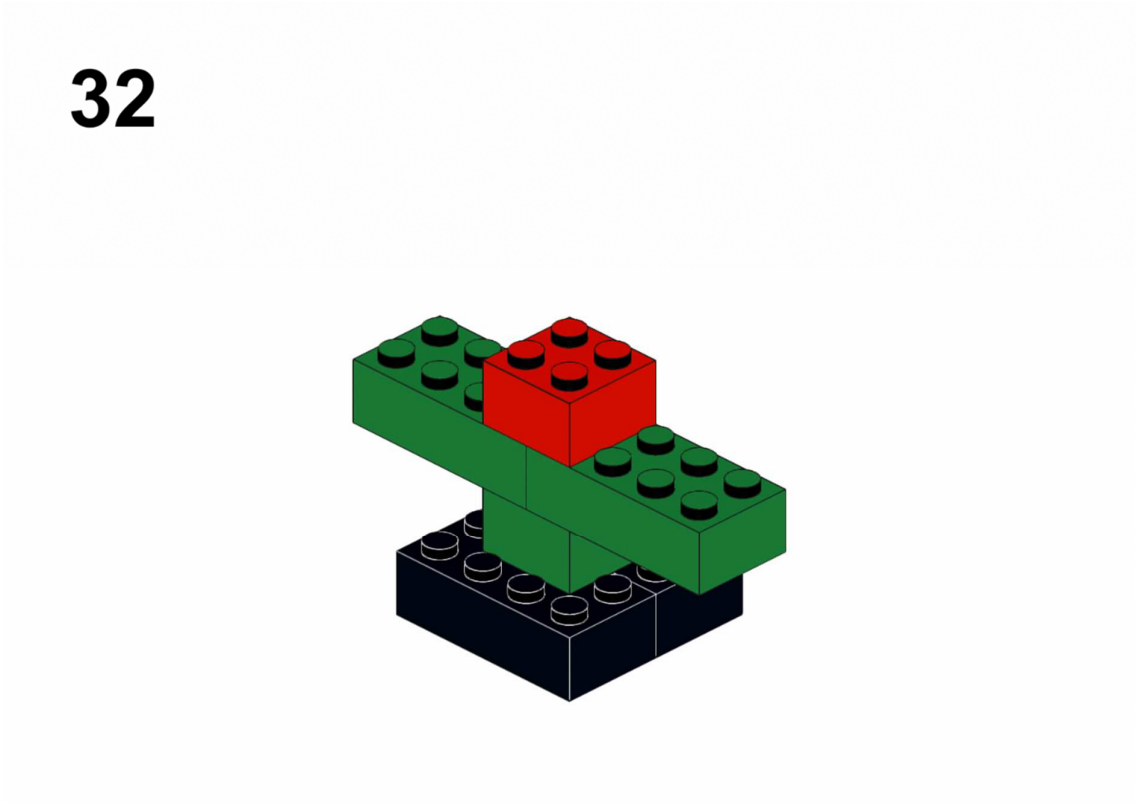



20
2x
21
1x
1x
22
1x
2x
1x
23
2x

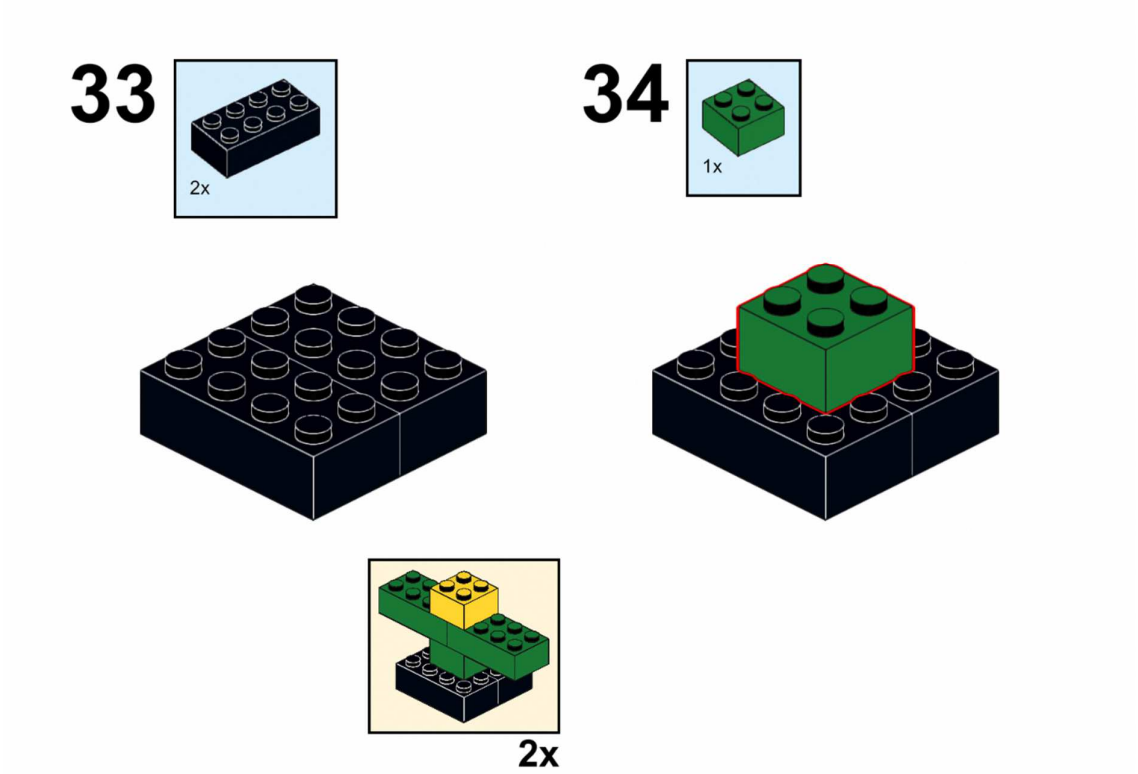

24
2x
25
2x
26
2x
27
1x
1x

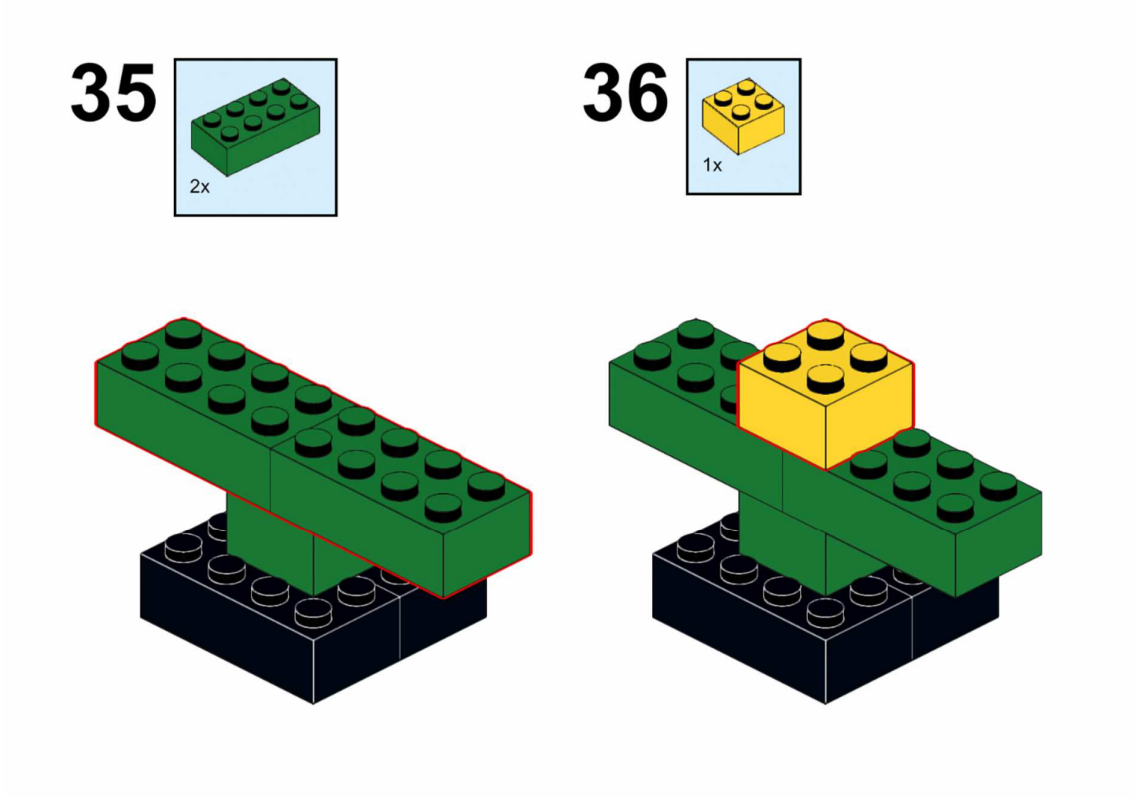
8.4C Red Flower Plant



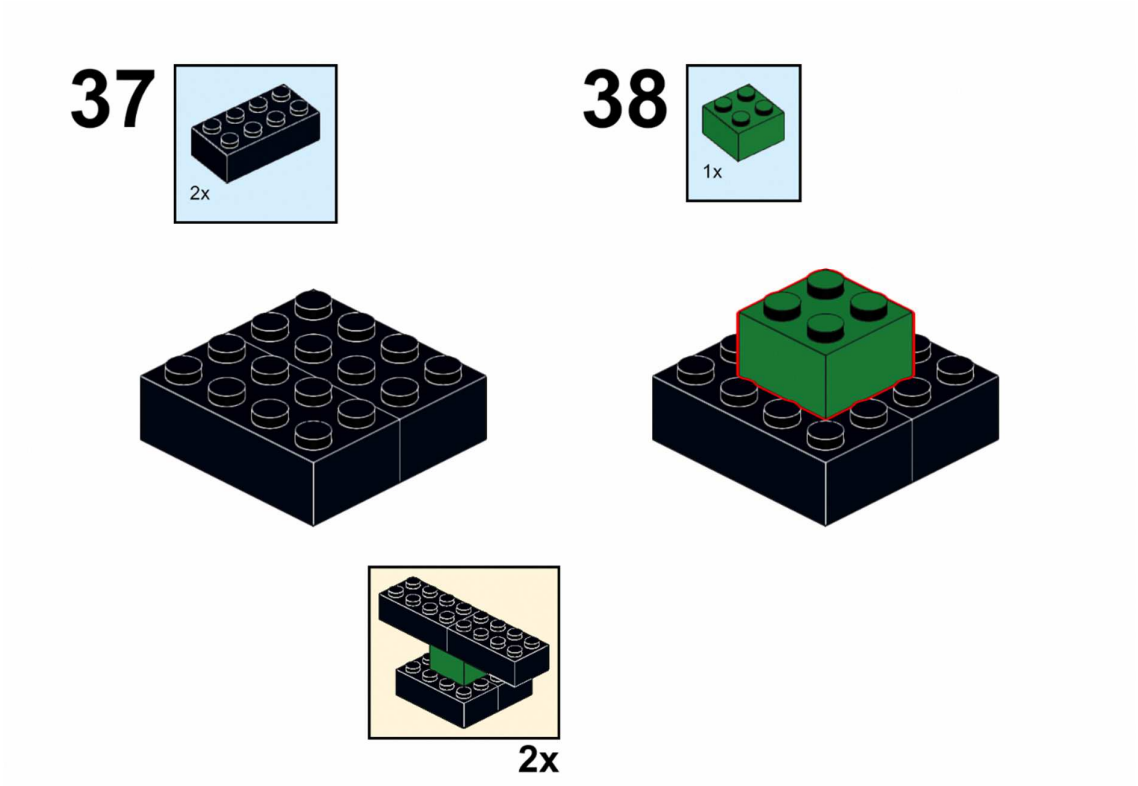


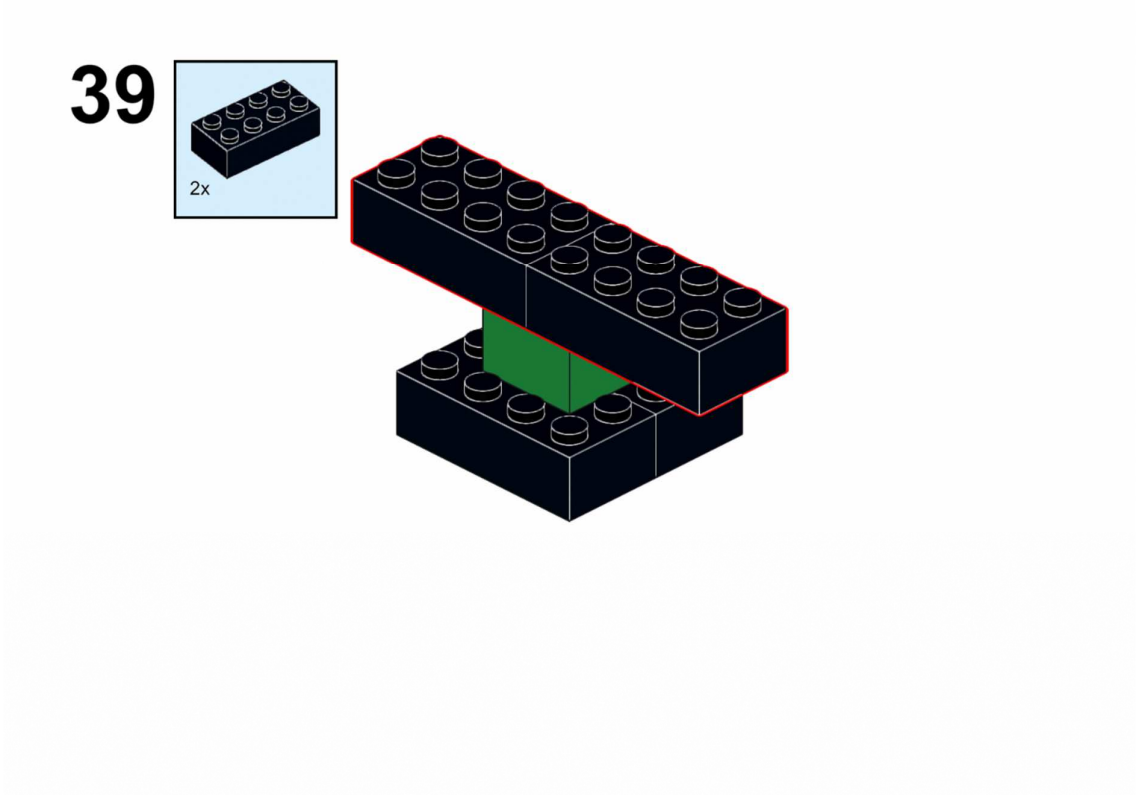
8.4D Yellow Flower Plant



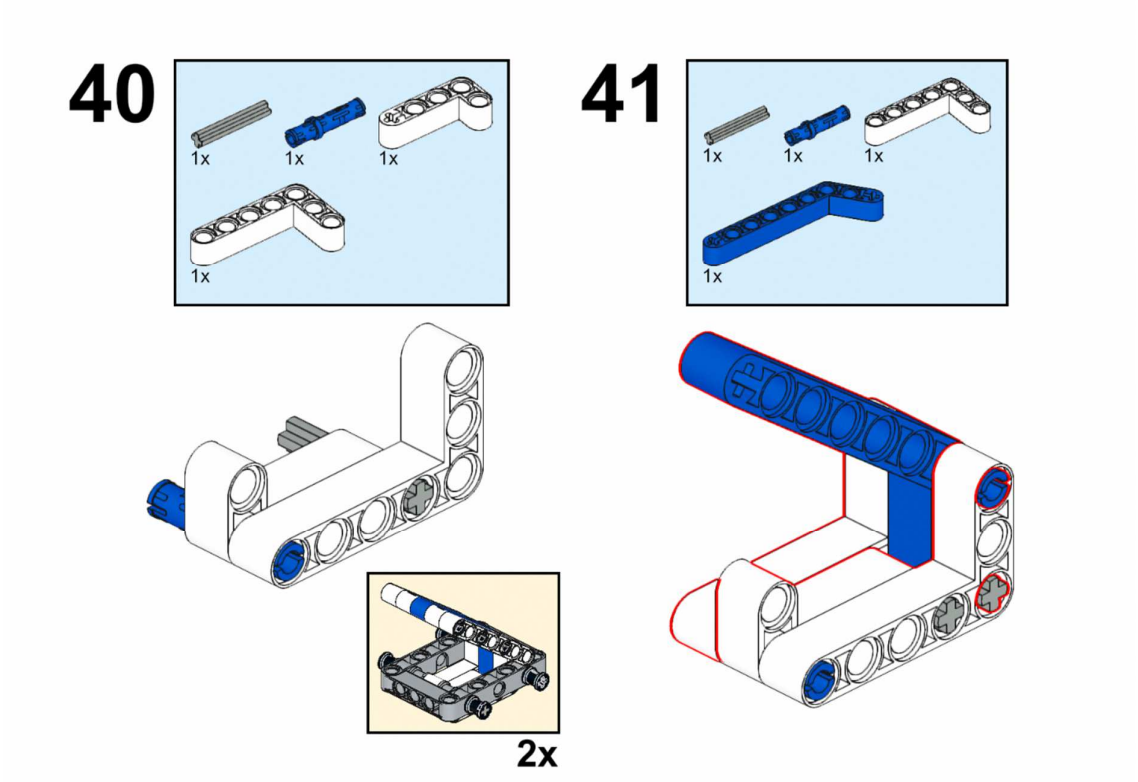


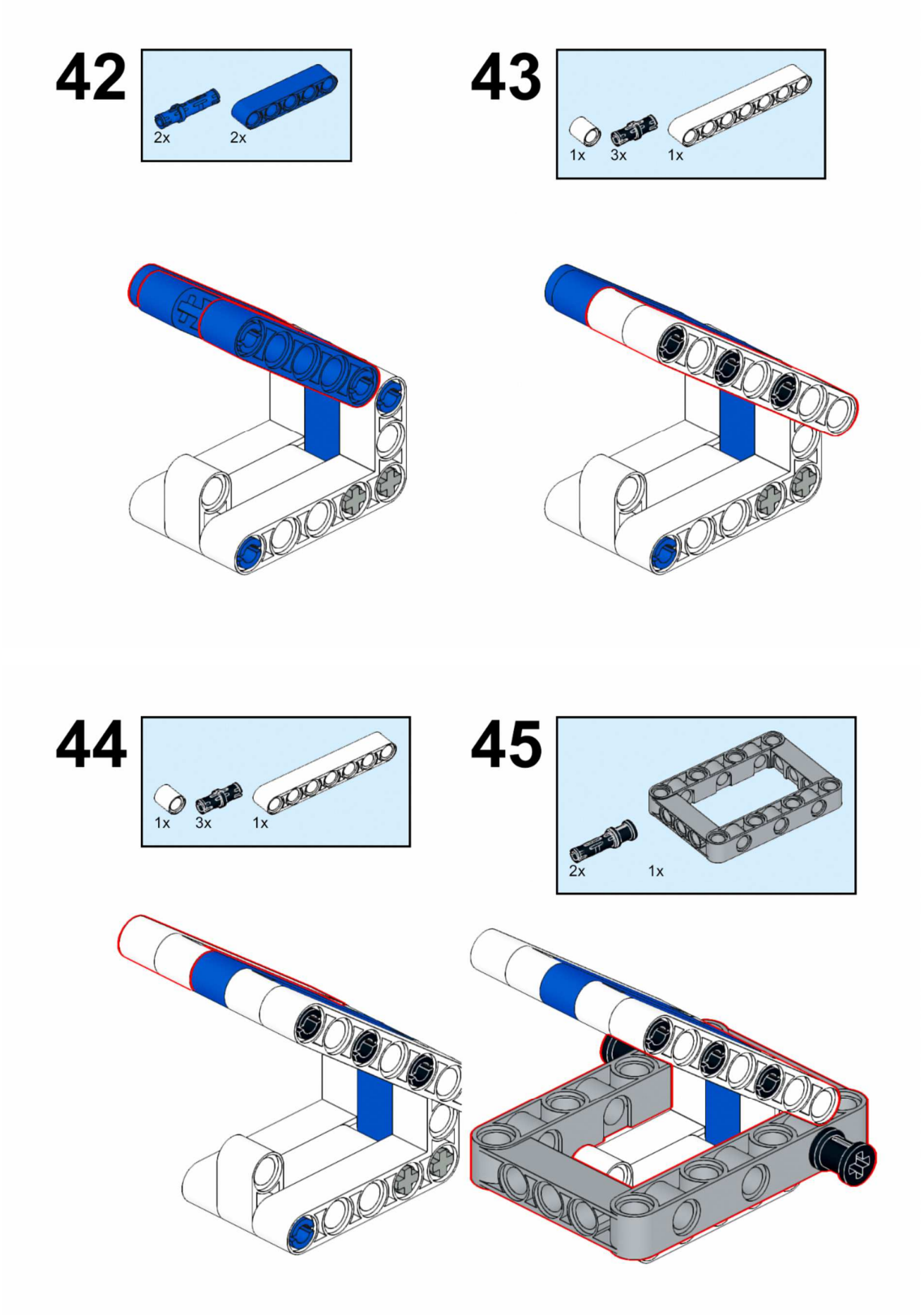
8.4E Fragile Seedling

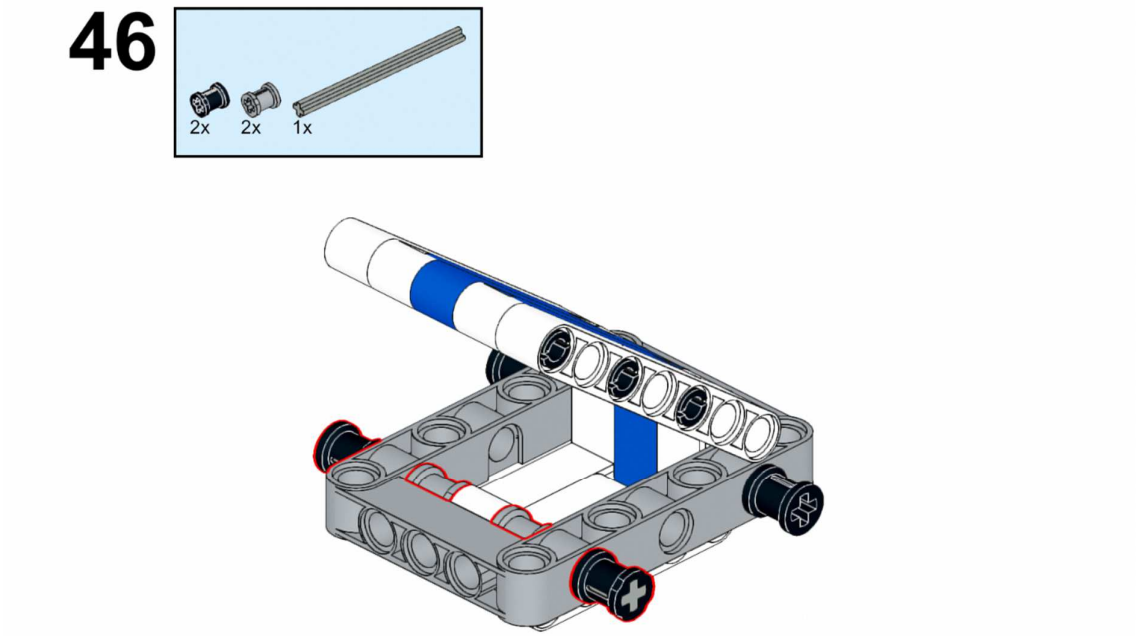


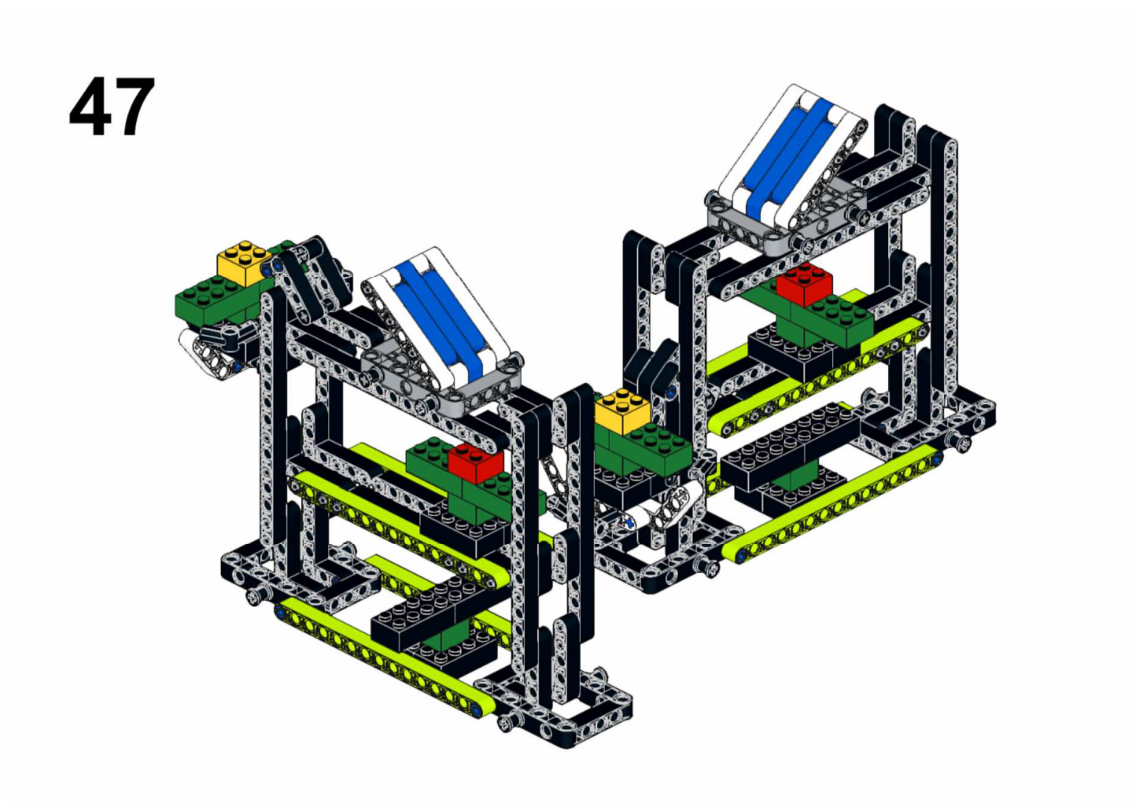


8.4F Solar Panel

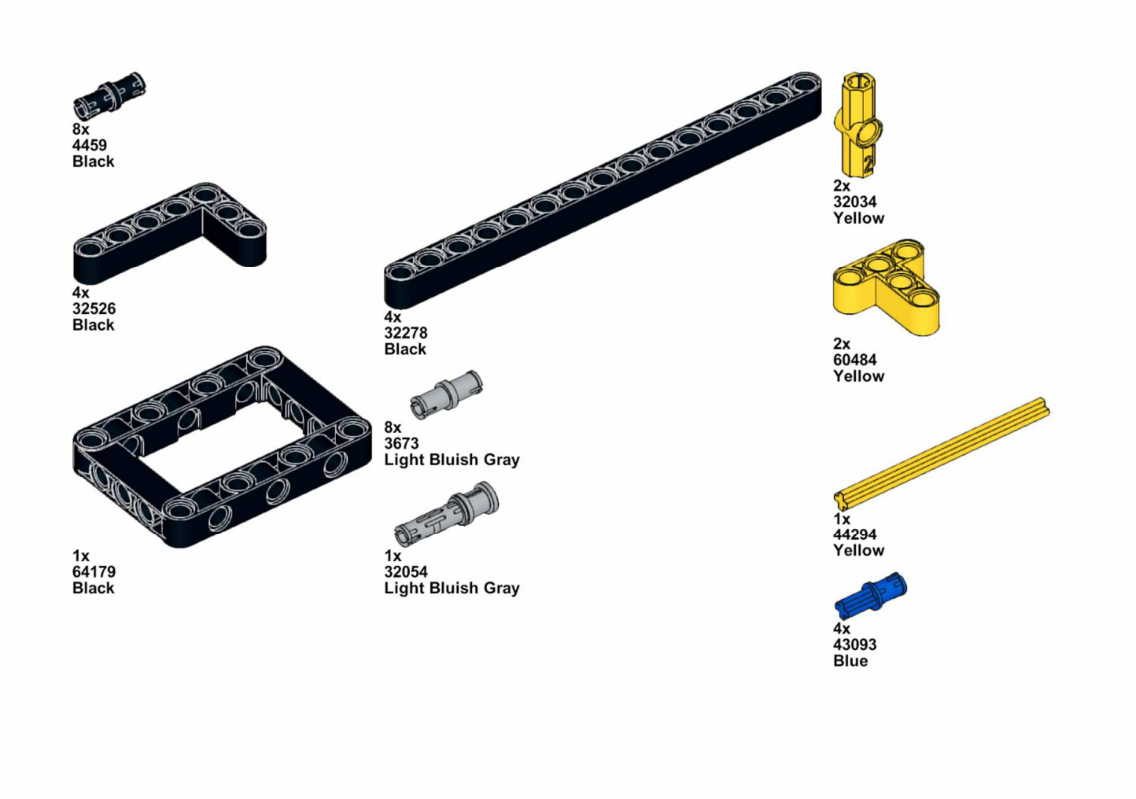


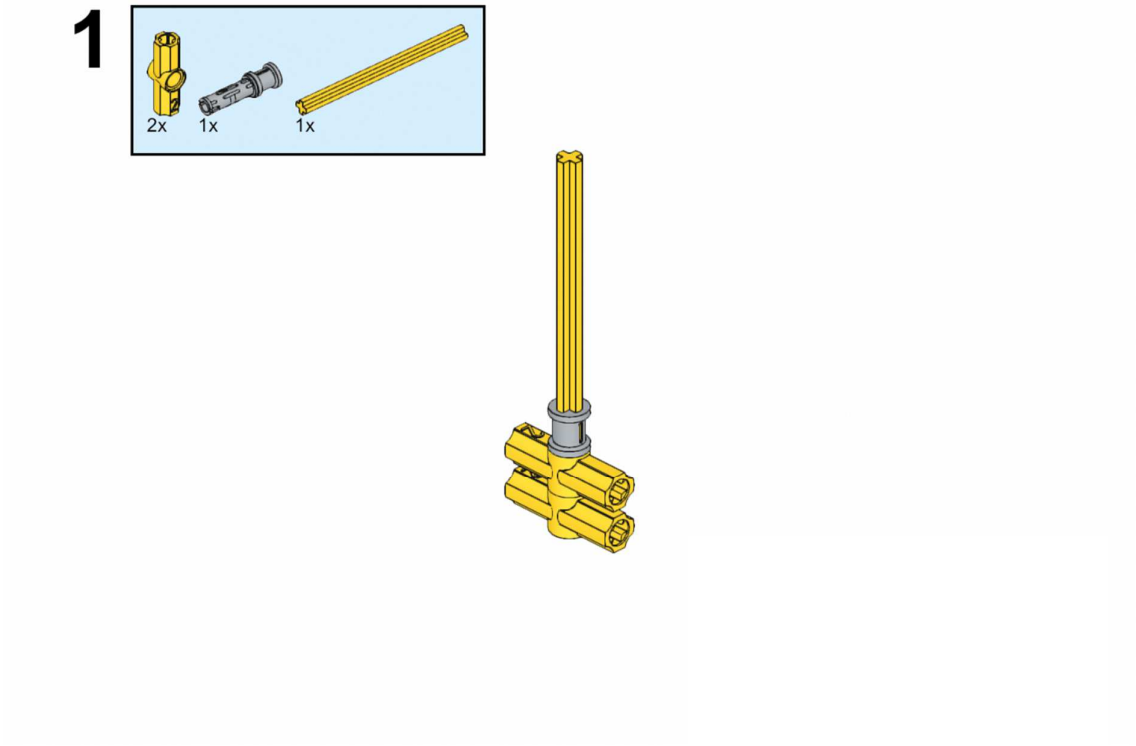

42
2x
2x
43
1x
3x
1x
44
1x
3x
1x
45
2x
1x

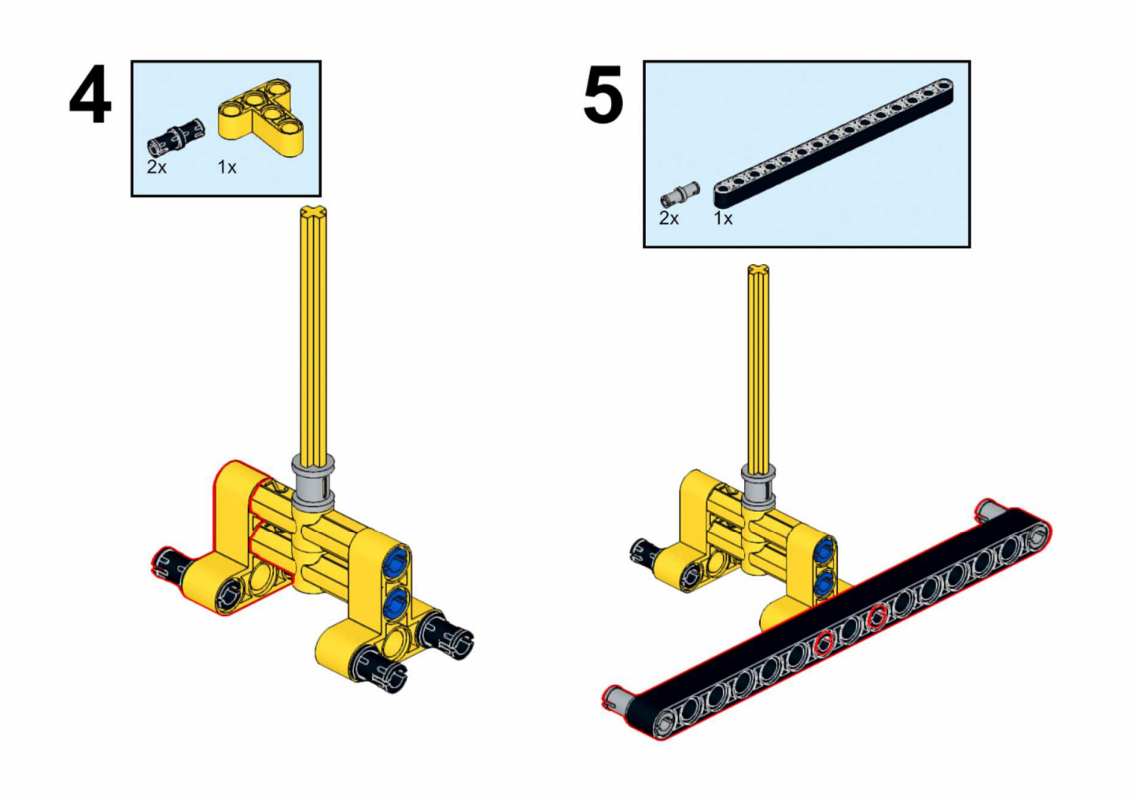

46
2x
2x
1x

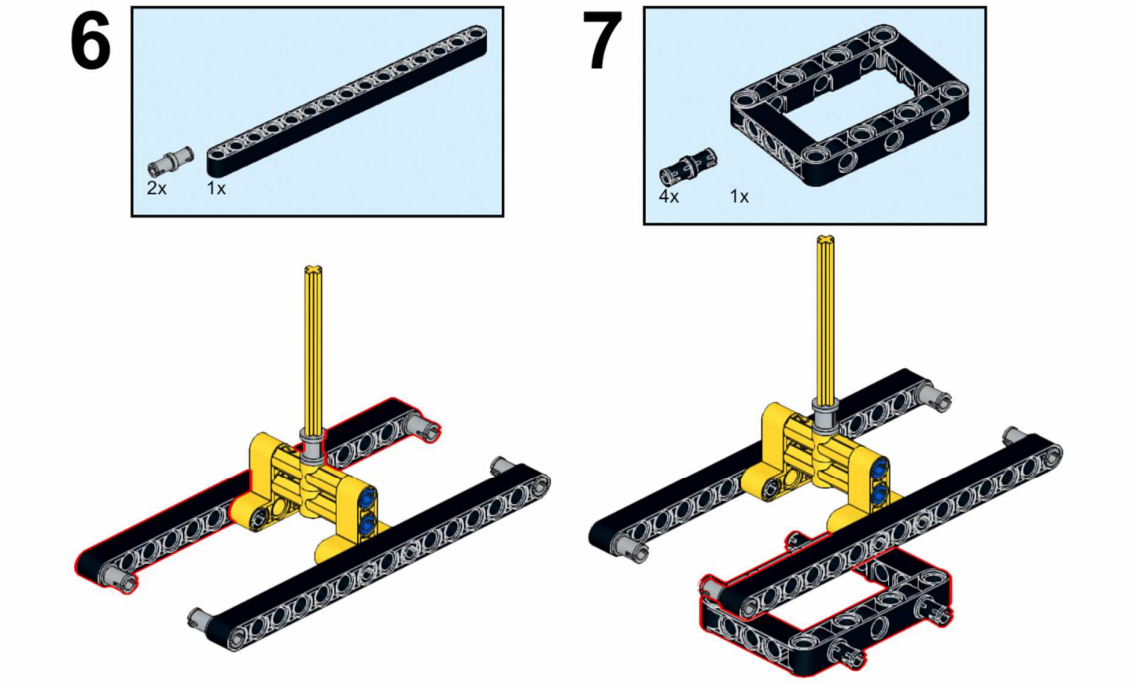

47

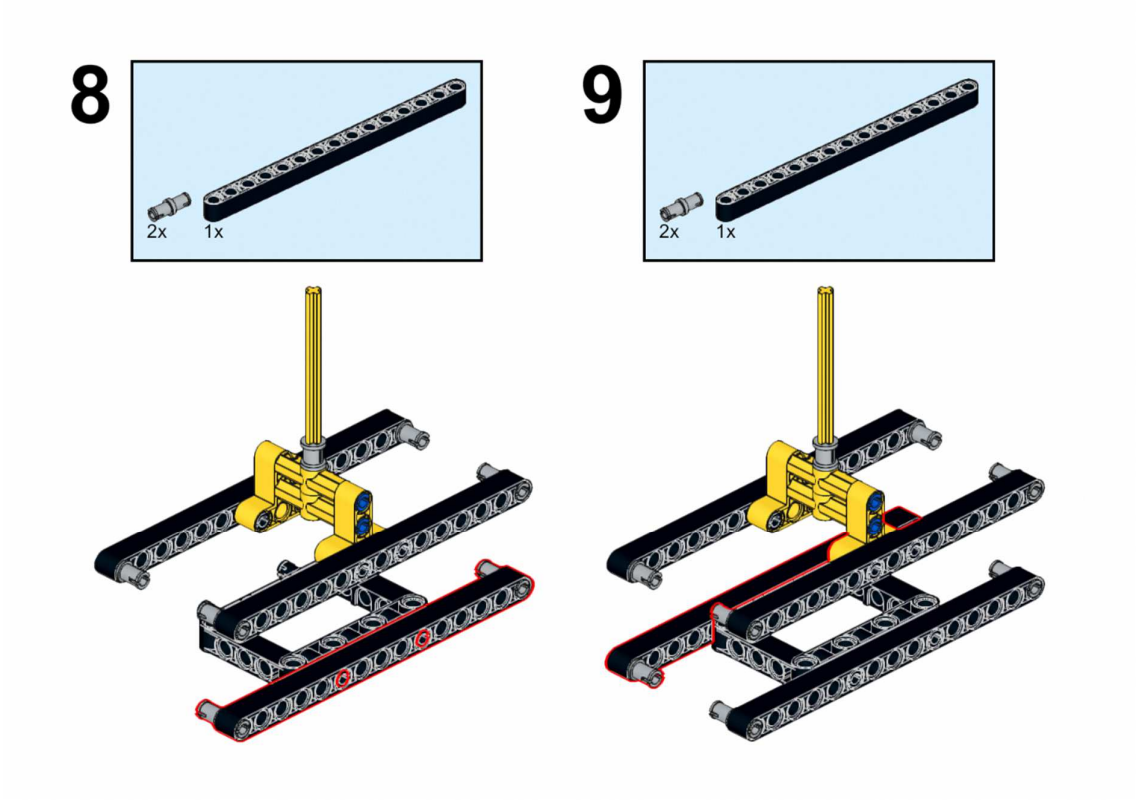
8.5 Return to Charging Station

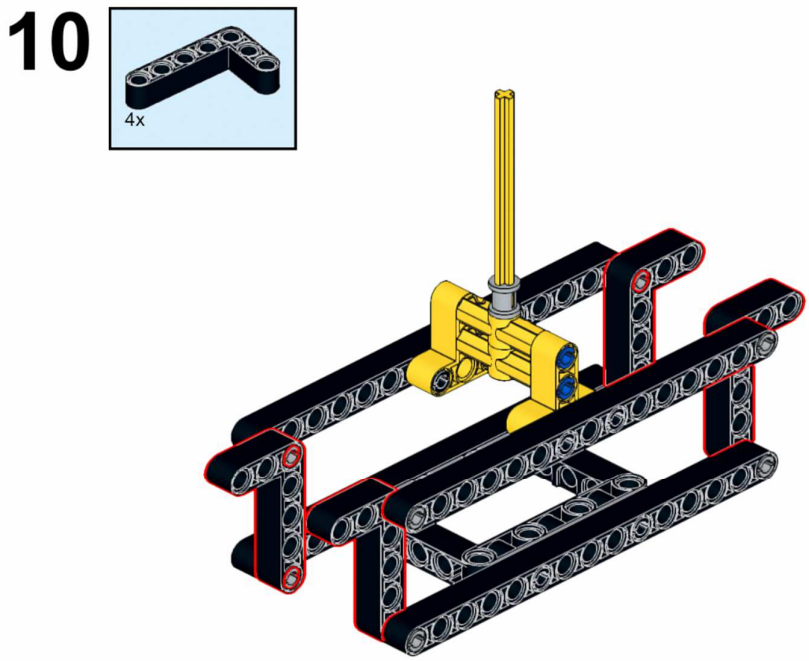



1
2x
1x
1x
2
4x
3
2x
1x

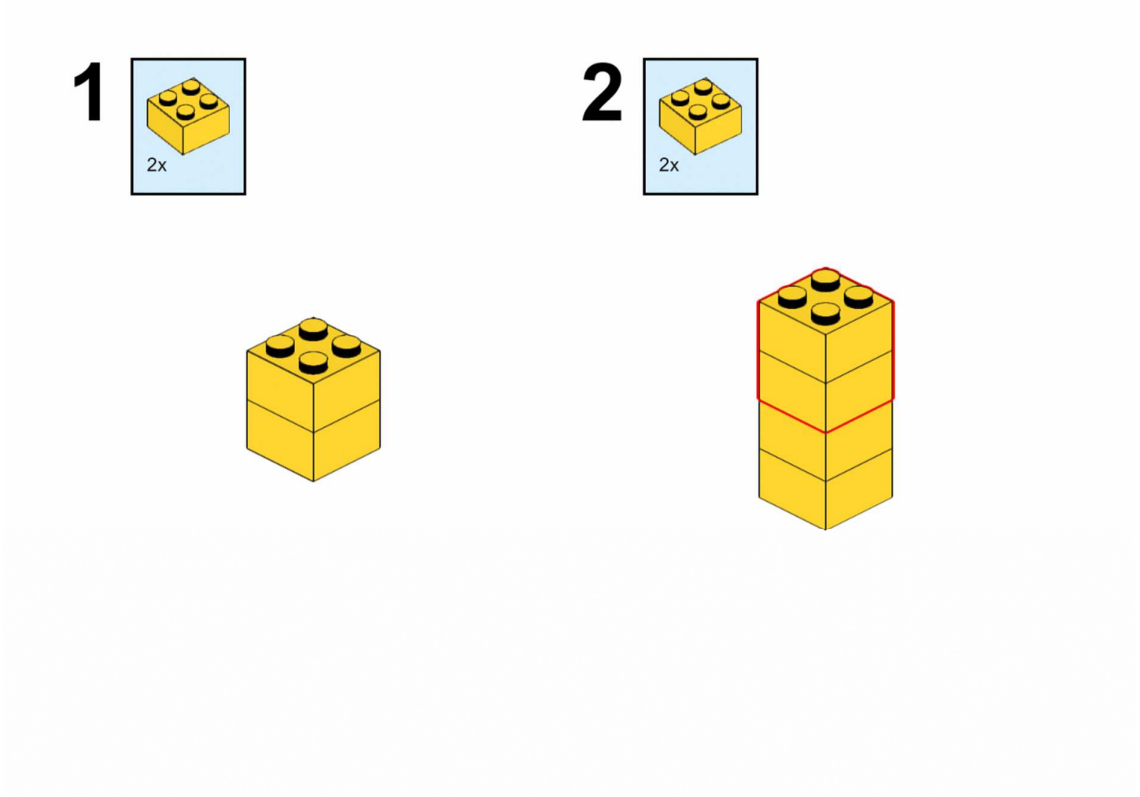

4
2x
1x
5
2x
1x


6
2x
1x
7
4x
1x


8
2x
1x
9
2x
1x


10
4x

8.6 Sun Beam



END