

NRC 2023 REGULAR CATEGORY

Upper Primary and Secondary

GAME RULES

Version: 30 March 2023

Organiser:



Sponsored by:



Ministry of Education
SINGAPORE

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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
1.1	30 March 2023	Assembly of Game Objects

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PART ONE – GAME DESCRIPTION

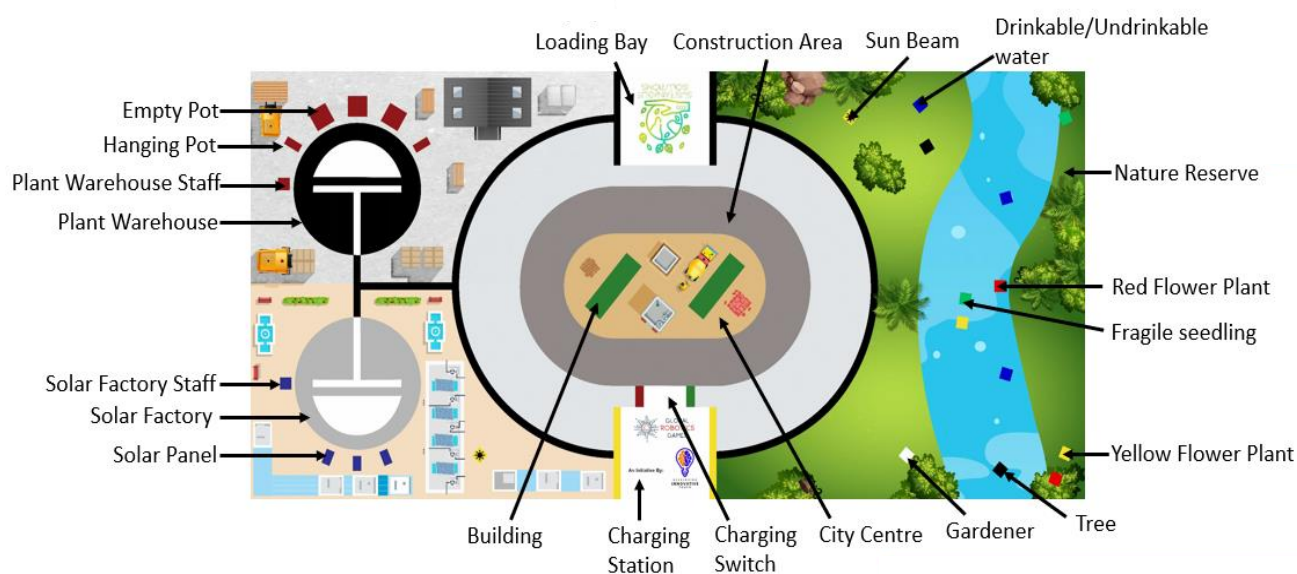
1. Introduction

A Green City is a city designed with consideration for social, economic and environment impact, and 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 human. Robots can also support the construction of buildings to reduce the need of manpower and carbon footprint.

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

2. Game Field



The following graphic 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 makes 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 at Construction Area).
- Teams are allowed to make physical adjustments to the robot 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 or switch program after their robot comes to a complete stop and it is partially in the Loading Bay.
- To unload props (Fragile Seedlings, Red Flower Plants and Yellow Flower Plants and the Hanging Pots only) from the robot after the robot comes to a complete stop and it is partially in the Loading Bay.
- To physically 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.
- 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 robot run.
- To physically move the Construction Equipment during robot run

3.4 Ending of Robot Run

A robot attempt 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, referee 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 is 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 joins the discussion with judges on the scoring of the run. Video or photo proofs will not be accepted.


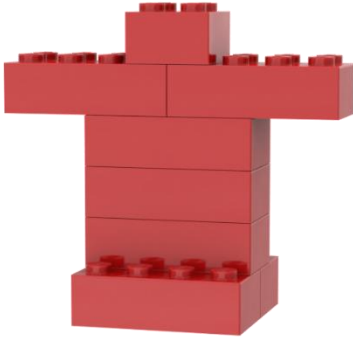

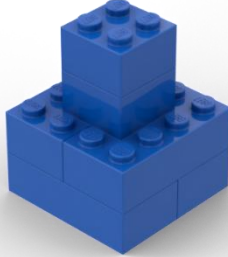
If a team finishes an attempt without having solved a (partial) task that yields positive points, the time of that run will be set at 120 seconds.

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:

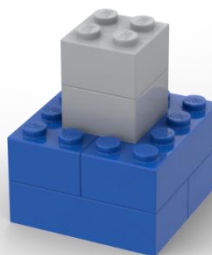
- Construction equipment will be used to aid the team in placing the props into the building in the City Centre.
- Each team can place multiple construction equipment in the construction area.
- The construction equipment can extend into the city centre as long as the base of the construction equipment 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 physically move the position of the construction equipment.
- Teams can only use non-motorize LEGO branded elements to build their construction equipment.

4. Game Objects, Positioning, Randomisation

<p>1 Gardener</p> <p>There is 1 Gardener in the white box in the Nature Reserve.</p>	
<p>1 Plant Warehouse Staff</p> <p>There is 1 Plant Warehouse Staff in the red box in the Warehouse.</p>	
<p>1 Solar Factory Staff</p> <p>There is 1 Solar Factory Staff in the blue box in the Factory.</p>	
<p>2 Drinkable Water</p> <p>There are 2 drinkable water blocks in 2 of the 3 blue boxes (random) in the Nature Reserve.</p>	

1 Undrinkable Water

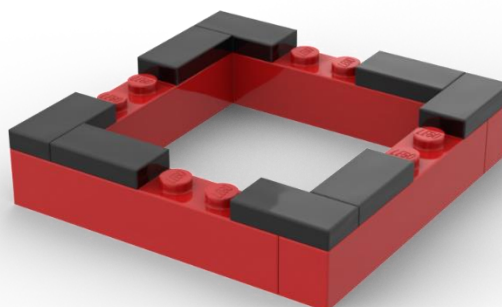
There is one non-drinkable block in the remaining blue box in the Nature Reserve.

**2 Trees**

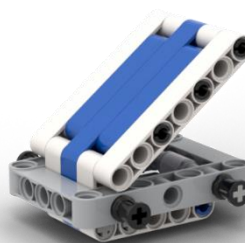
There are 2 trees in the 2 black boxes in the Nature Reserve.


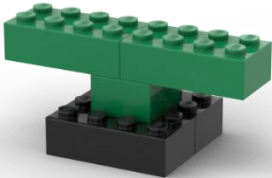
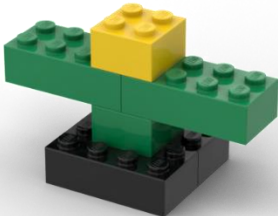
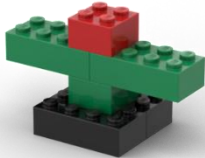
**2 Empty Pot**

There are 2 empty pots in the Warehouse in 2 of the 3 big Red Boxes.

**2 Solar Panels**

There are 2 Solar Panels in the Factory in 2 of the 3 big Blue Boxes.



<p>1 Sun Beam</p> <p>There is 1 Sun Beam block in one of the 2 yellow boxes closest to the City Centre. This block will indicate the direction that the Solar Panel will need to face.</p>	
<p>2 Fragile Seedling</p> <p>There are 2 fragile seedling in the 2 Green boxes within the Nature Reserve,</p>	
<p>2 Yellow Flower Plant</p> <p>There are 2 Yellow Flower Plant in the 2 Yellow boxes within the Nature Reserve,</p>	
<p>2 Red Flower Plant</p> <p>There are 2 Red Flower Plant in the 2 Red boxes within the Nature Reserve,</p>	

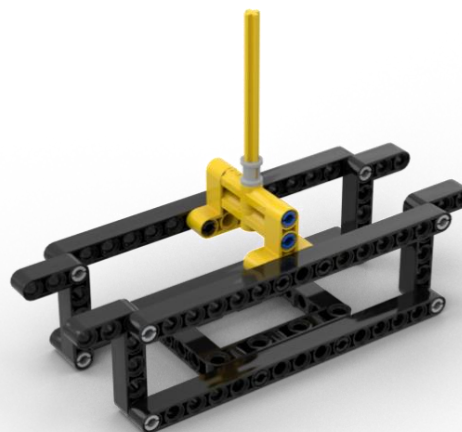
2 Hanging Pots

There are 2 Hanging Pots in the 2 Red Rectangles in the Warehouse.

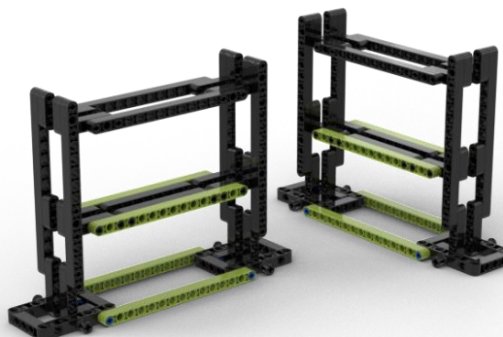
**1 Charging Switch**

There is 1 Charging Switch located above the charging point.

This will be secured onto the playmat using double sided tape, with the starting position towards the red line.

**2 Empty Building**

There are 2 empty buildings within the City Centre in the green boxes.

**One start area**

Only one start area on the field at the Charging Point. Before the start of the run, the robot must fit completely in the 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.

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.

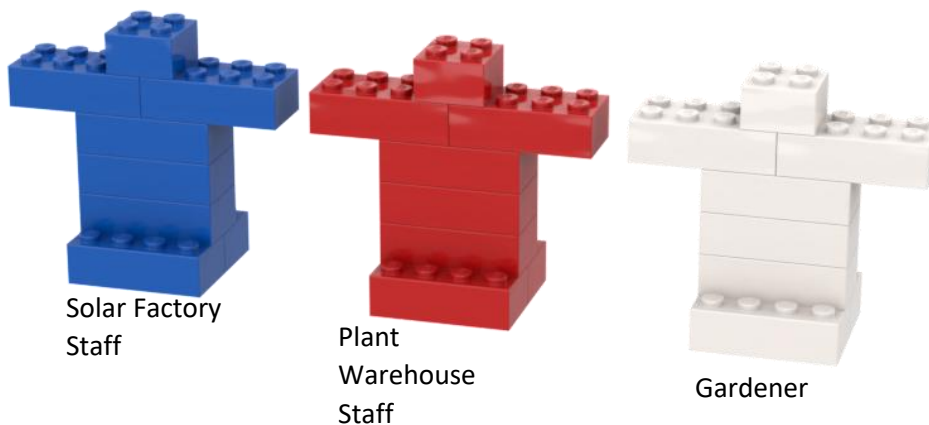
Scoring for each mission will be:
Final State (scoring is done when the Robot Attempt ends)

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 1 Gardener (White), 1 Plant Warehouse Staff (Red) and 1 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 remained upright in the City Centre.



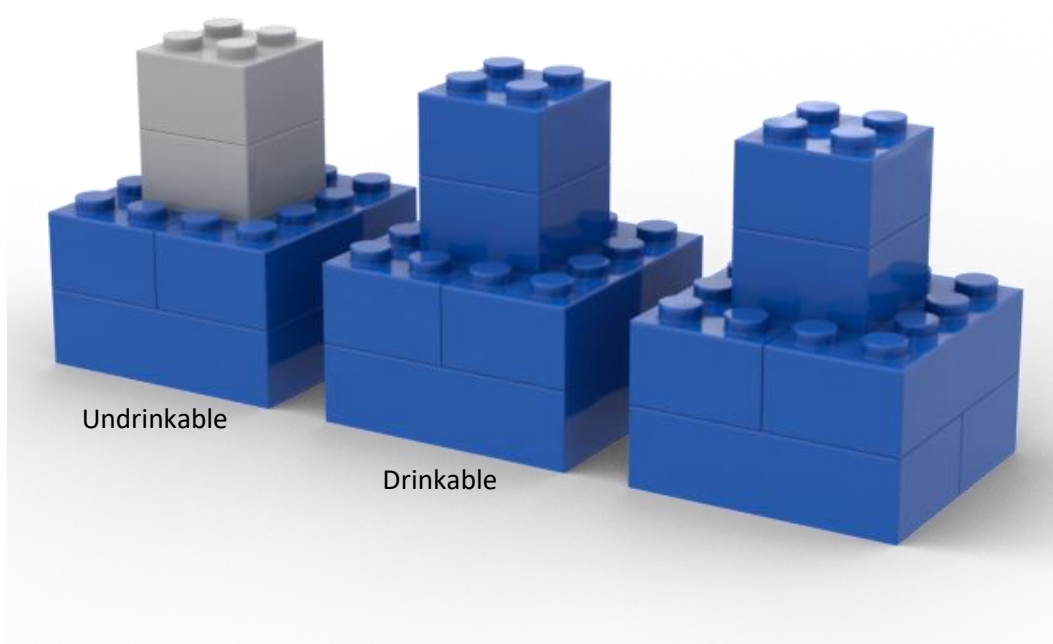
5.2 Water Management

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 Undrinkable (Gray Indicator). There are always 2 Drinkable and 1 Undrinkable, placed in random positions in the 3 blue boxes in the Nature Reserve.

The robot should identify the drinkable water and the undrinkable water. The drinkable water is to be transported to the city centre.

Full points are awarded if only drinkable water is completely inside City Centre.

Negative score is applied when undrinkable water is partially or completely inside City Centre.

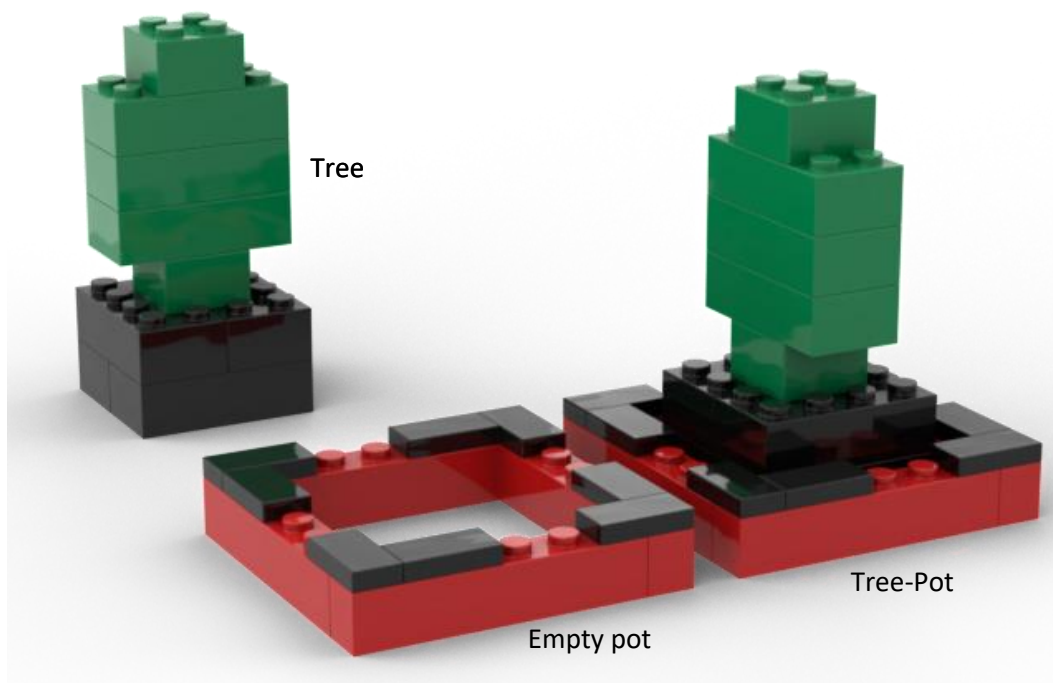


5.3 Tree Management

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 was underway.

There are only 2 empty pots randomly placed on 3 red boxes in the warehouse. The robot is to transport the Trees and placed them into the empty pots prepared at the Warehouse. 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 2 of the 3 blue boxes in the factory area. Your task is to collect the solar panels from the solar factory and place it 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 according to the direction of the Sun Beam whereby the top of the blue solar panel should be facing towards the Sun Beam.

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

- Fragile Seedlings cannot withstand harsh conditions and should only be planted on the low level. Your task is to plant the Fragile Seedlings on the ground floor of the building.
- Beautify the buildings with greeneries. Your task is to decorate the mid-level garden 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 the side of the building. The 2 hanging pots can be found in the warehouse.

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

- Teams can program the robot to gather all the Fragile Seedlings, 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 handled by the teams.
- Once the robot has completely stopped in the Loading Bay, team members are allowed to physically place the items onto their Construction Equipment.
 - For the Yellow Flower Plant and Hanging Pot, teams are not allowed to physically combine them. 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 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 action from the Robot.
- Bonus points will be awarded to teams if they return all their Construction Equipment back to the Warehouse area after use.

Full points are awarded if:

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

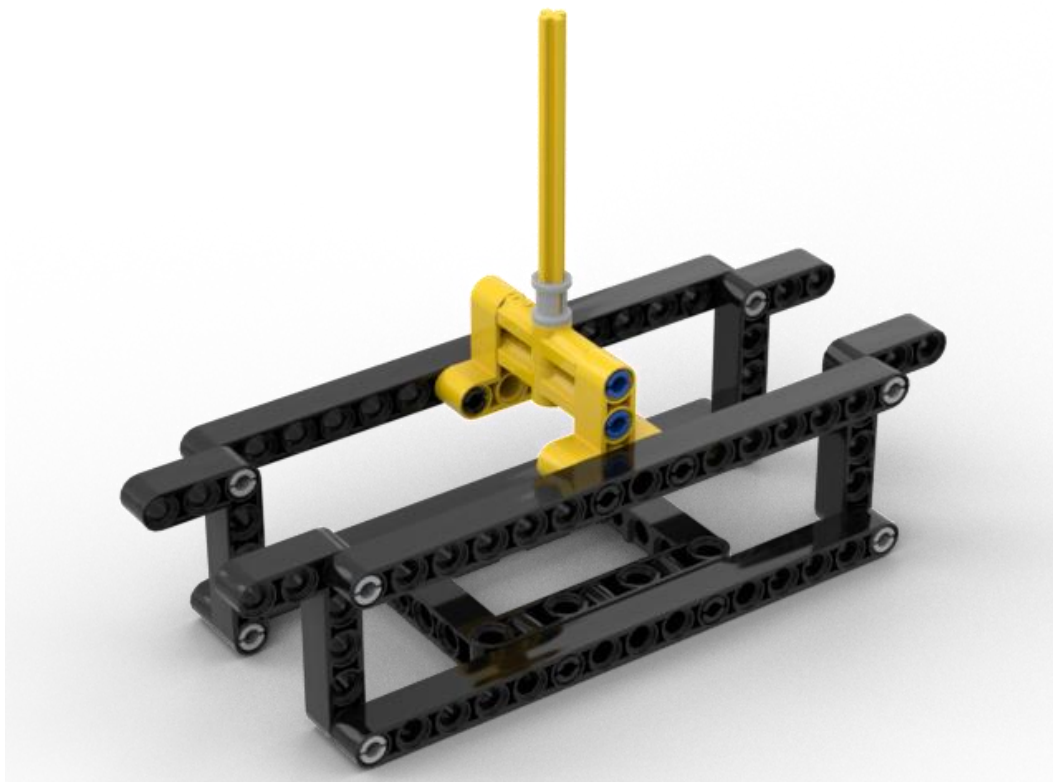


5.5 Return to charging station

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).

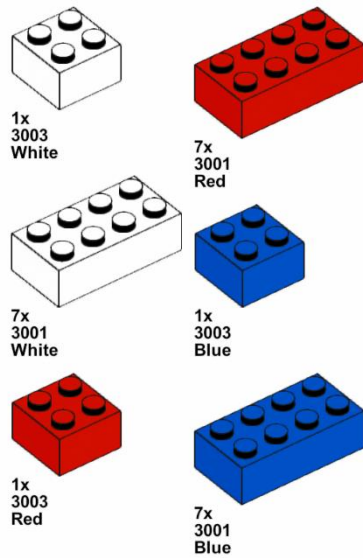
Tasks	Each	Total
1. Public Shuttle Service		
Staff (Blue, Red and White) standing upright and completely in City Centre	5	15
2. Water Management		
Potable water extracted from river	5	10
Potable water extracted from river and in the City Centre	10	20
Undrinkable water in the City Centre	-20	-20
3. Tree 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

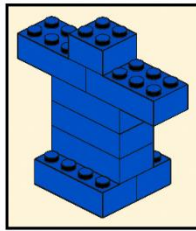
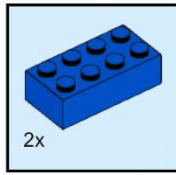
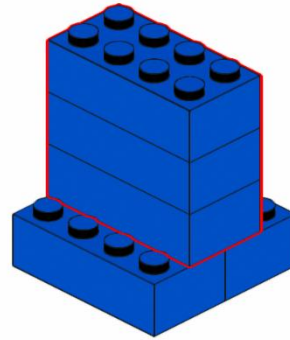
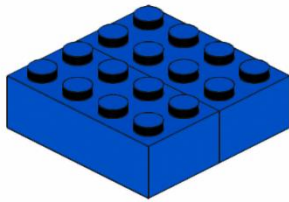
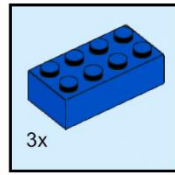
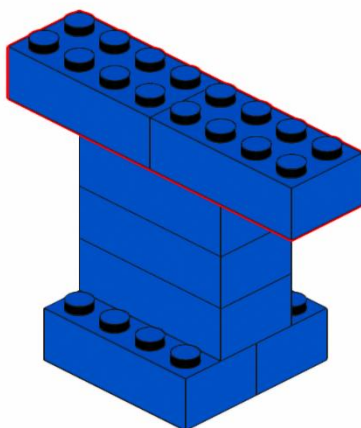
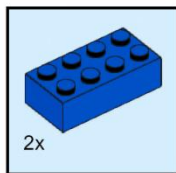
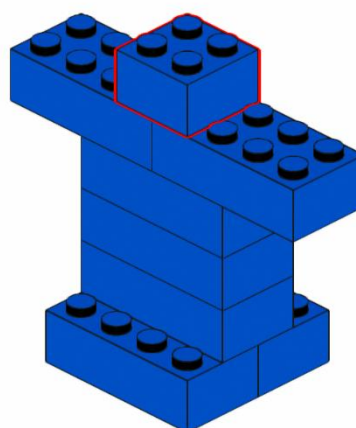
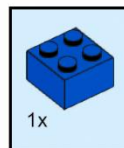
- Scoring Interpretation will be released at a later date -

8. Assembly of Game Objects

8.1 Public Shuttle Service

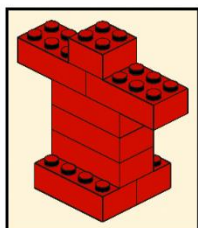
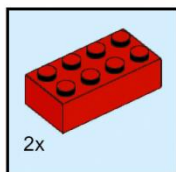


8.1A Solar Factory Staff

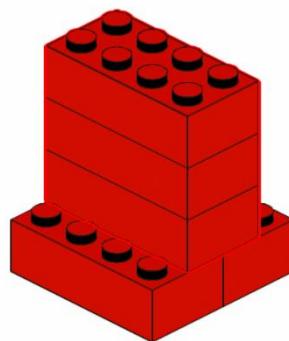
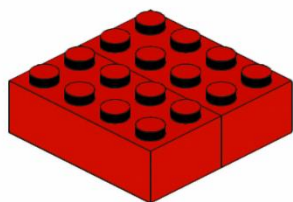
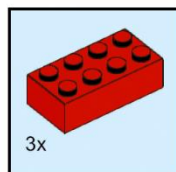
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8.1B Plant Warehouse Staff

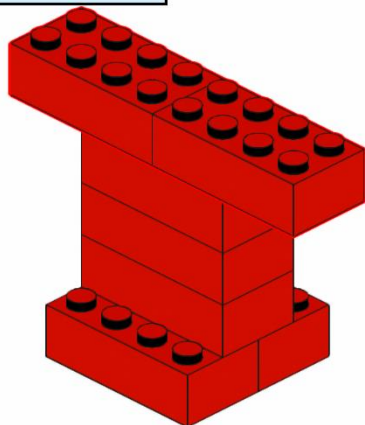
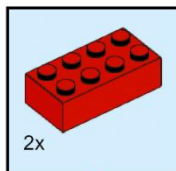
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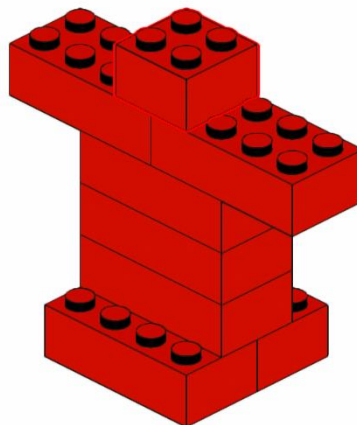
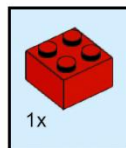
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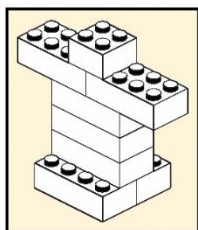
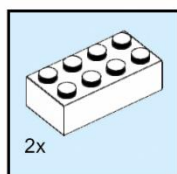


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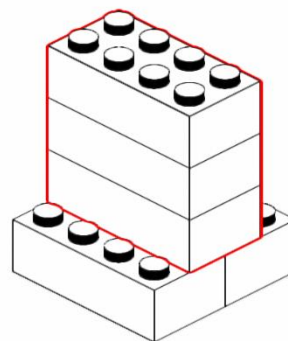
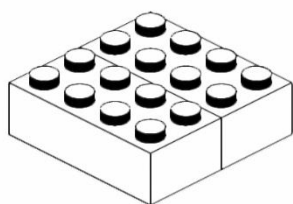
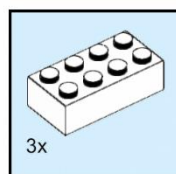


8.1C Gardener

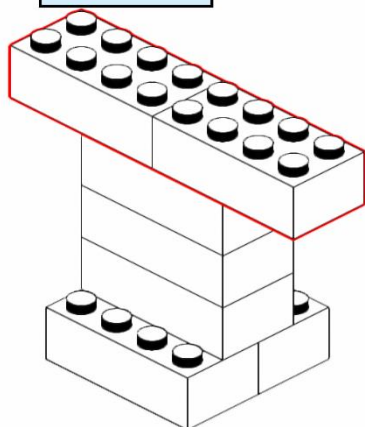
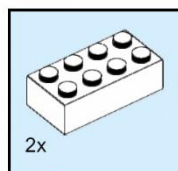
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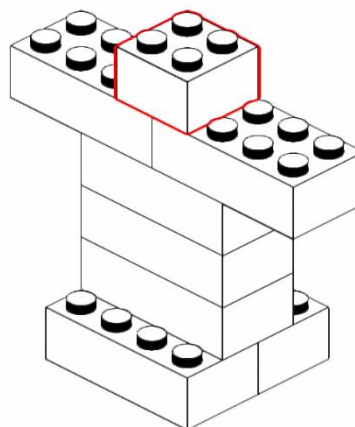
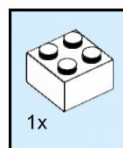
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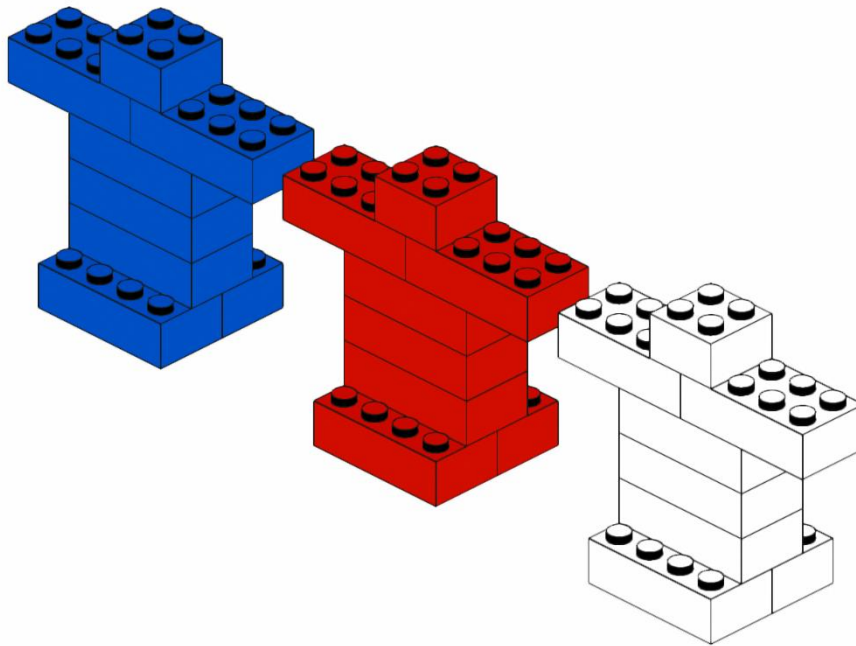
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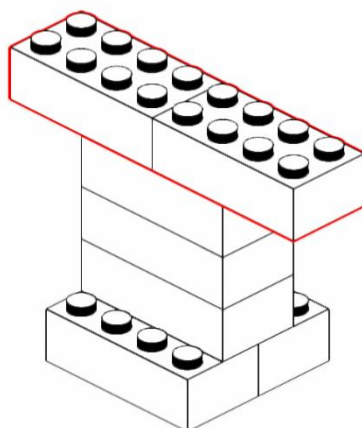
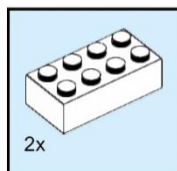
12



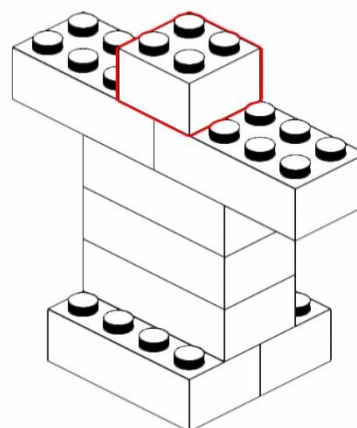
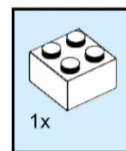
13



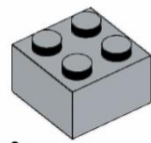
11



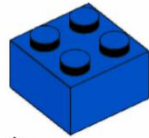
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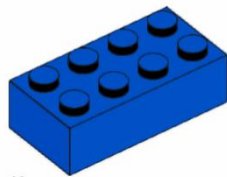
8.2 Water Management



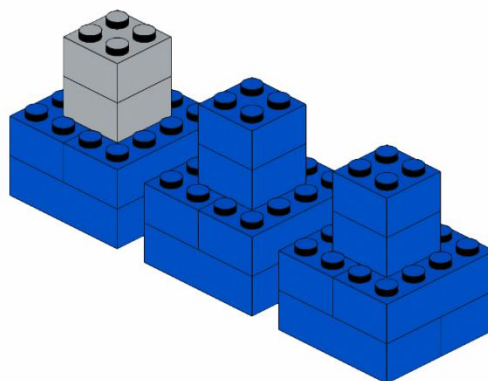
2x
3003
Light Bluish Gray



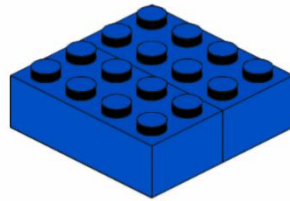
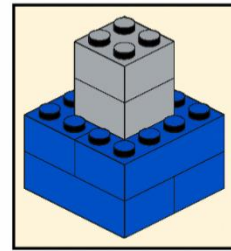
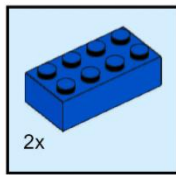
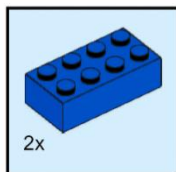
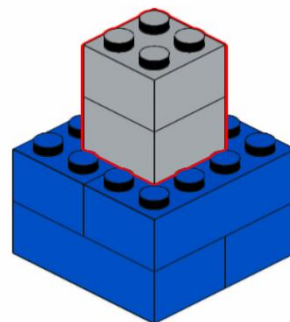
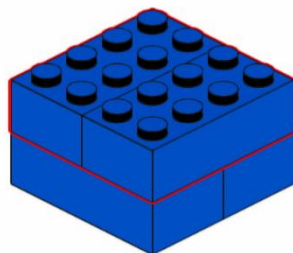
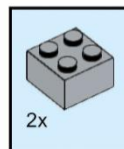
4x
3003
Blue



12x
3001
Blue

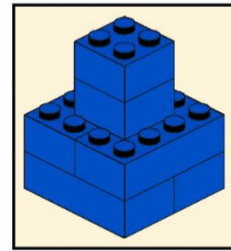
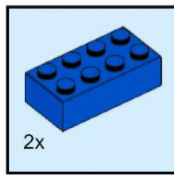


8.2A Undrinkable Water

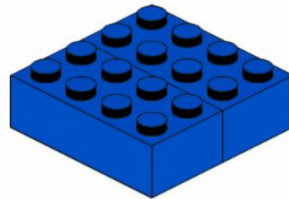
1**2****3**

8.2B Potable Water

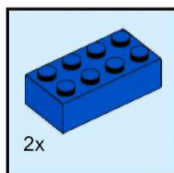
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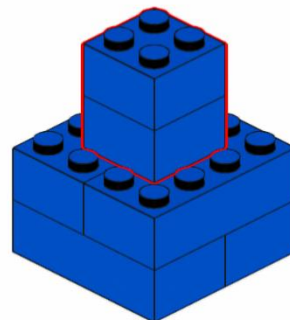
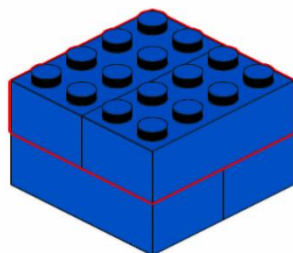
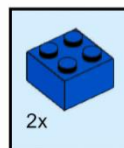
2x



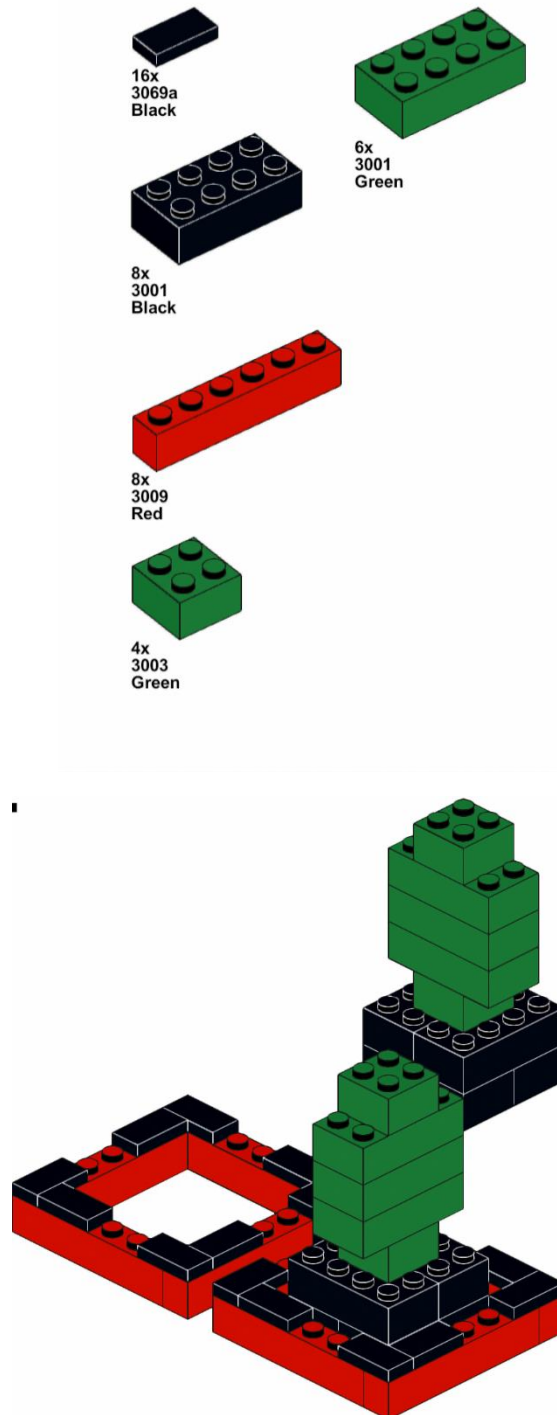
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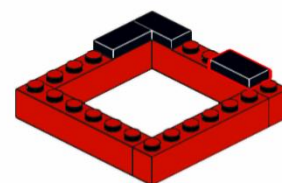
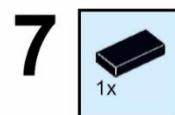
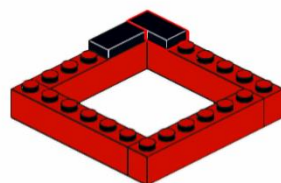
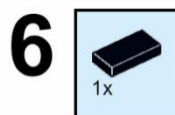
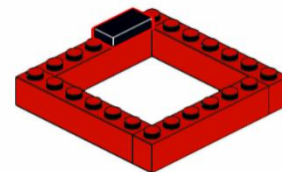
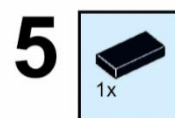
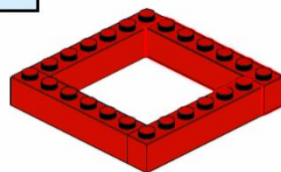
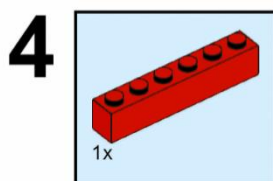
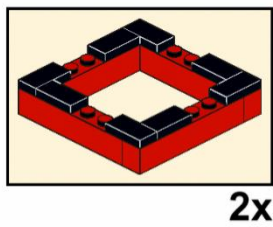
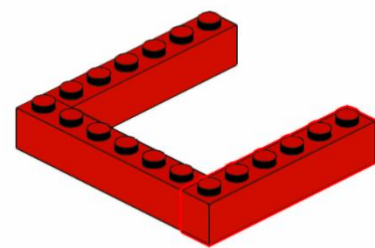
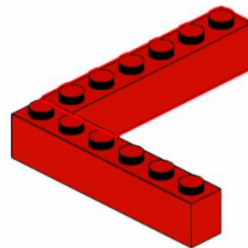
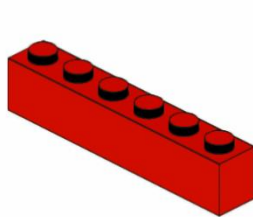
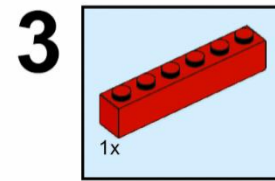
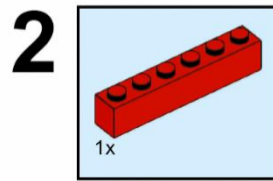
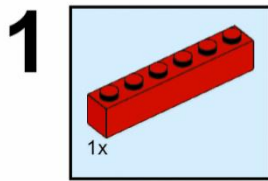
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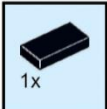
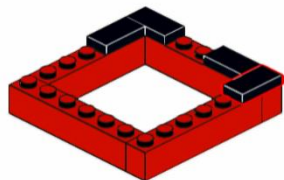
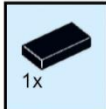
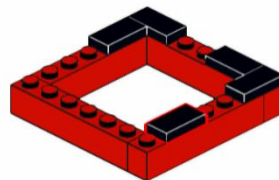
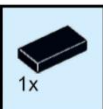
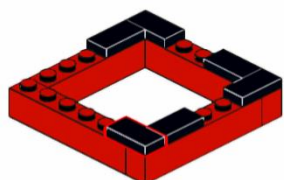
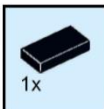
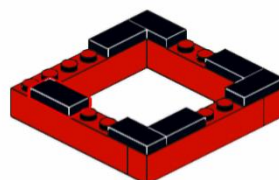
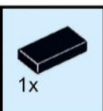
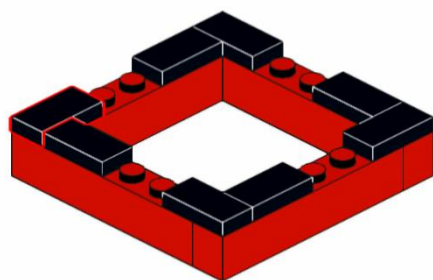


8.3 Tree Management

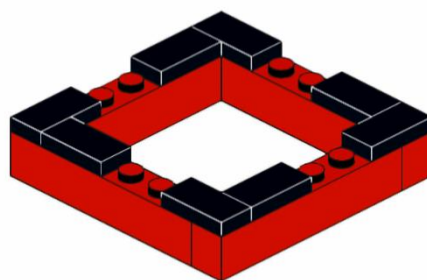


8.3A Empty Pot



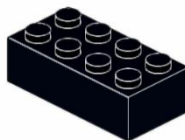
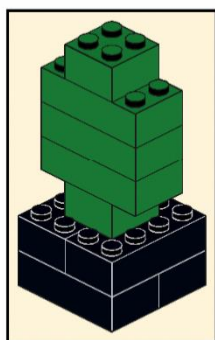
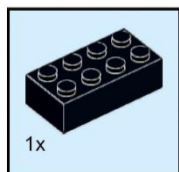
8  1x9  1x10  1x11  1x12  1x

13

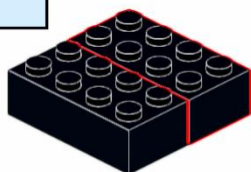
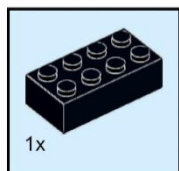


8.3B Plant

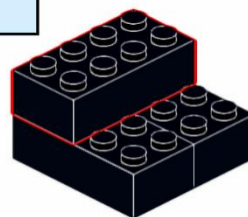
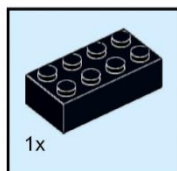
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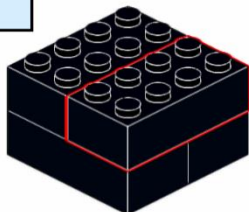
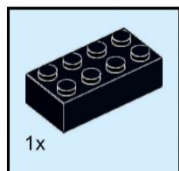
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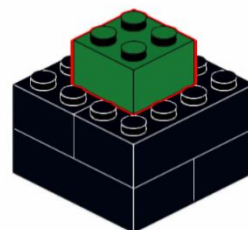
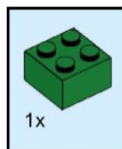
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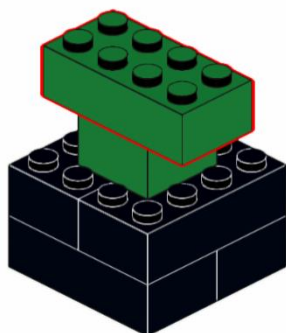
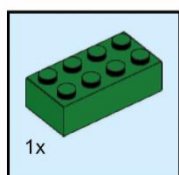
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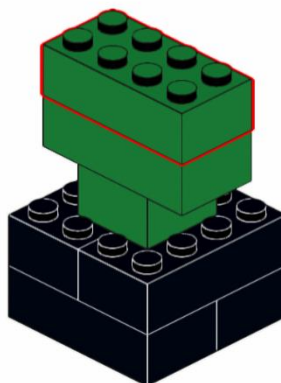
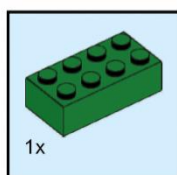
18



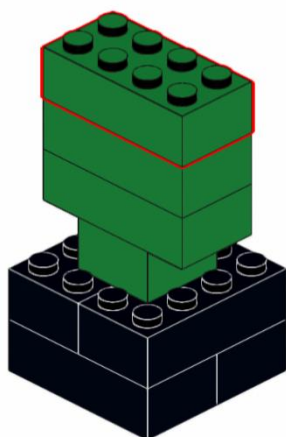
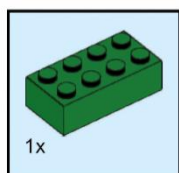
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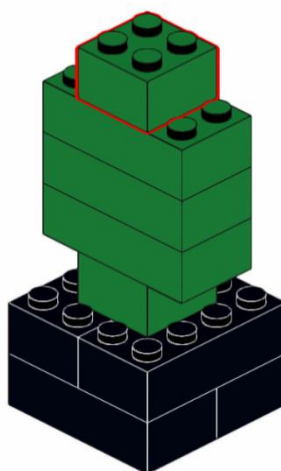
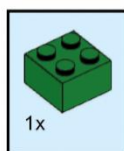
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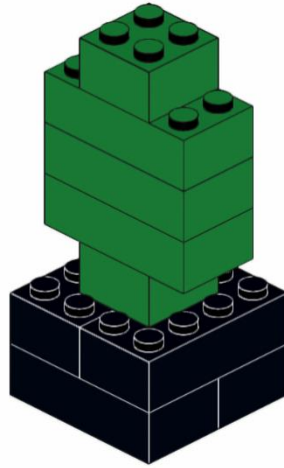
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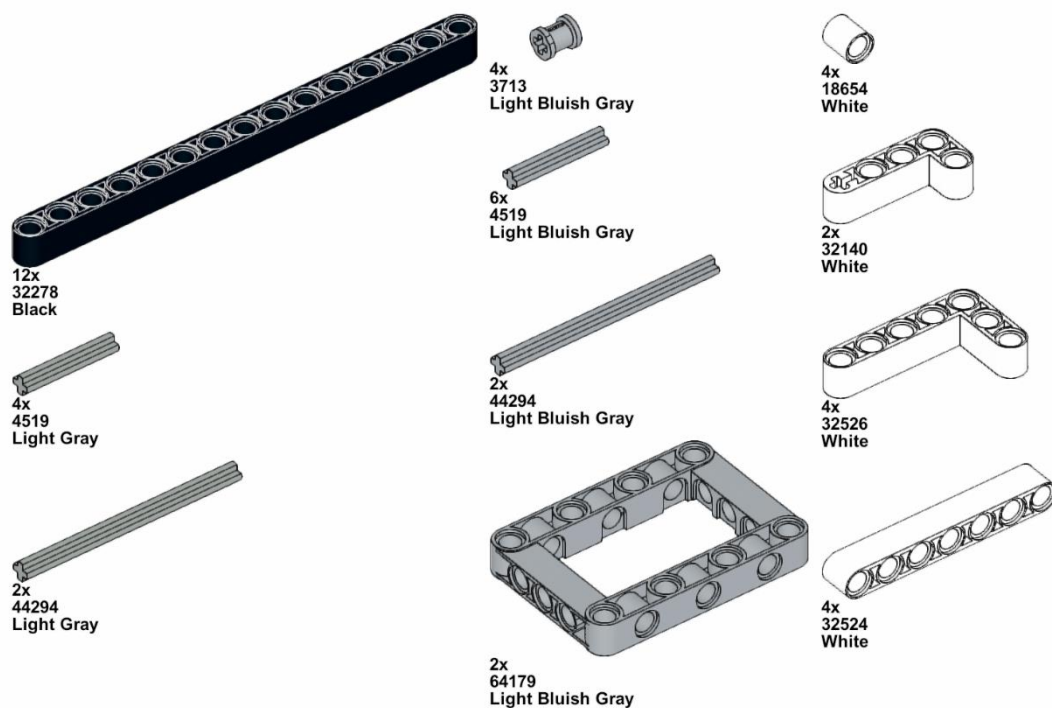
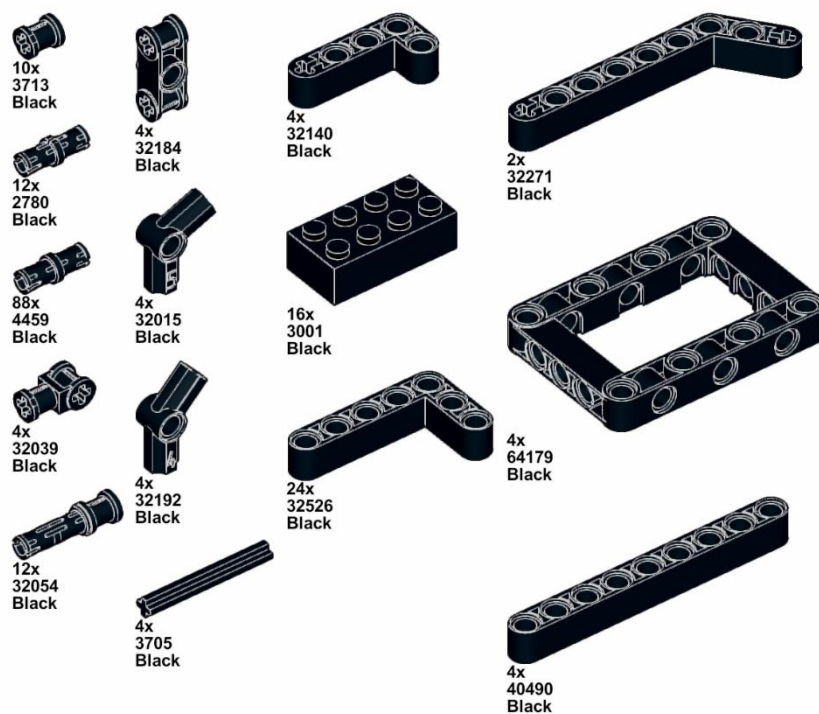
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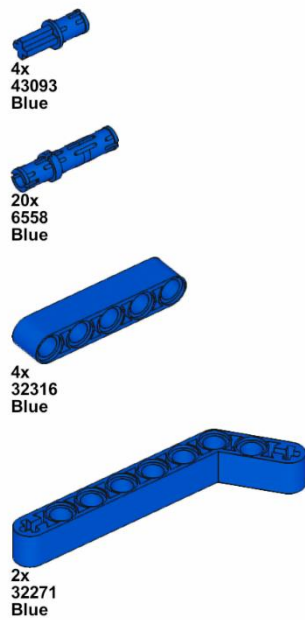
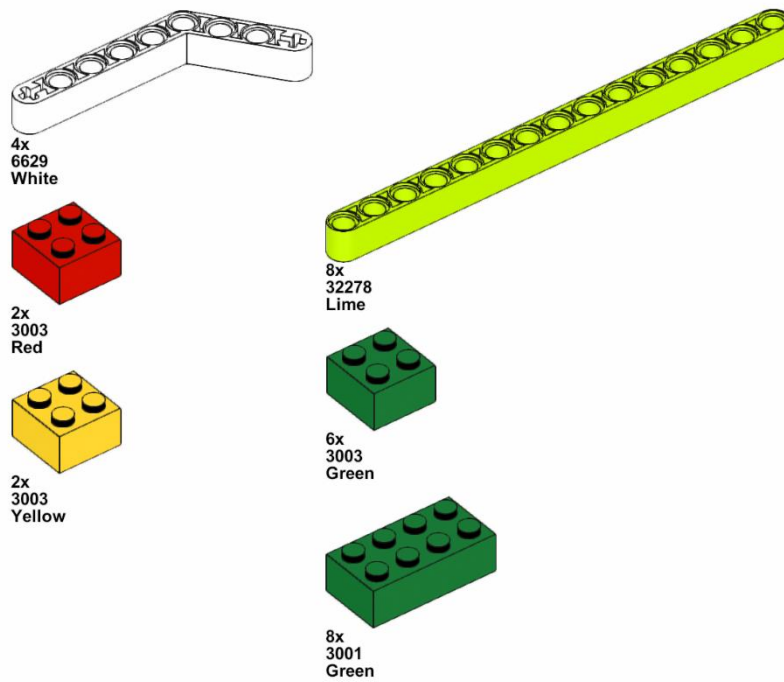


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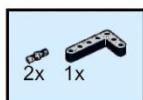


8.4 City Management

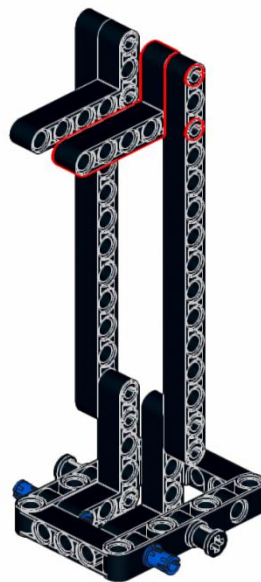
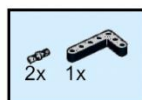




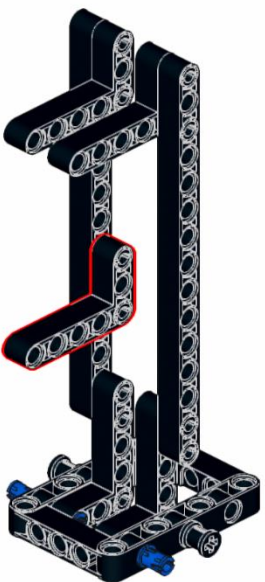
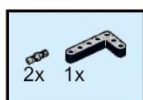
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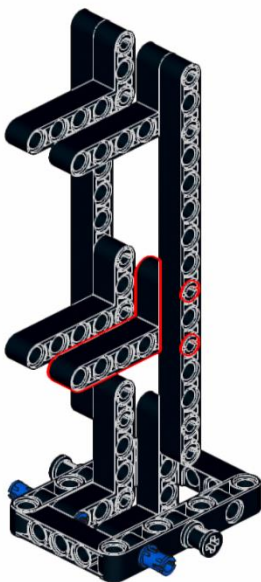
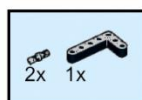
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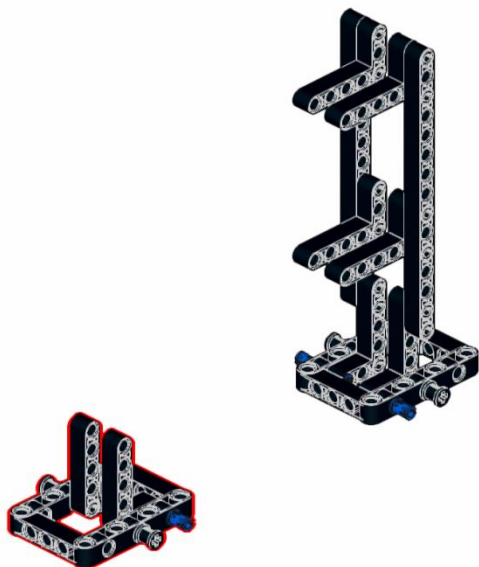
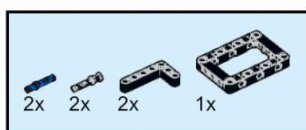
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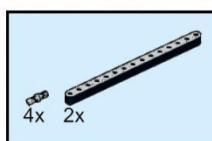
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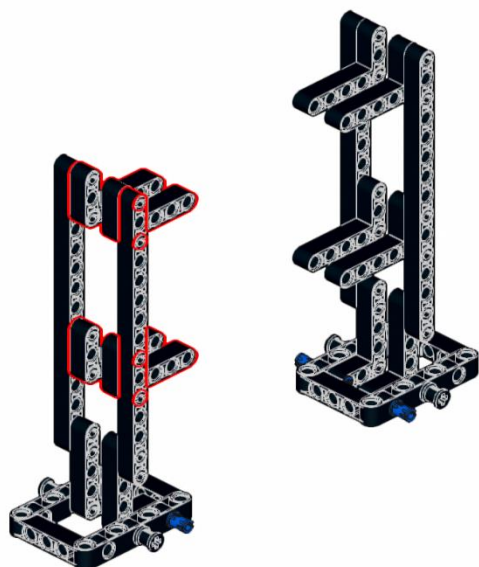
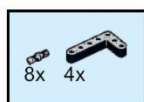
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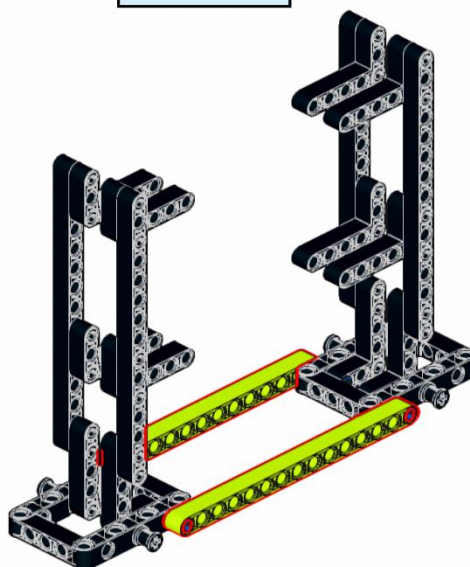
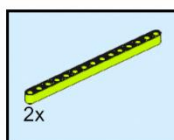
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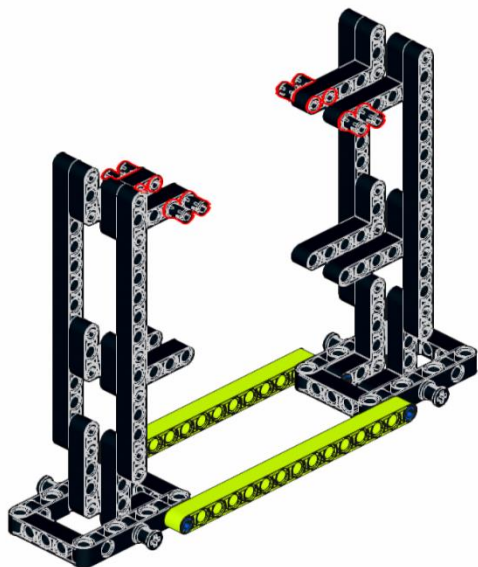
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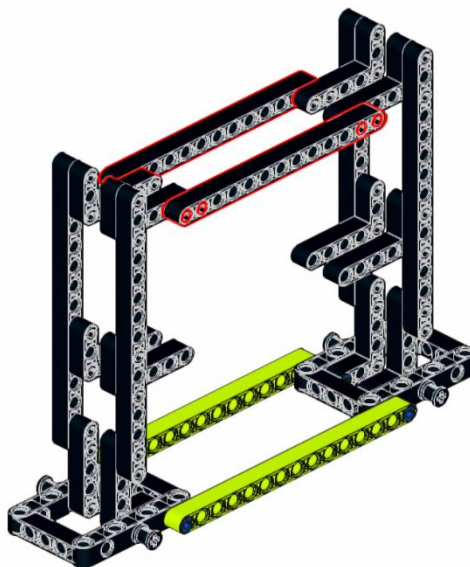
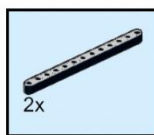
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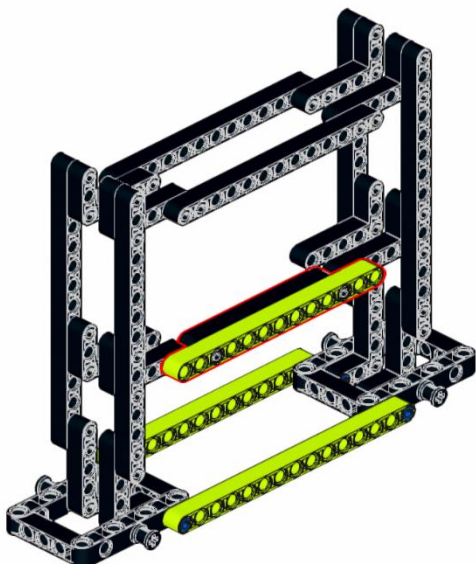
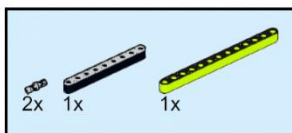
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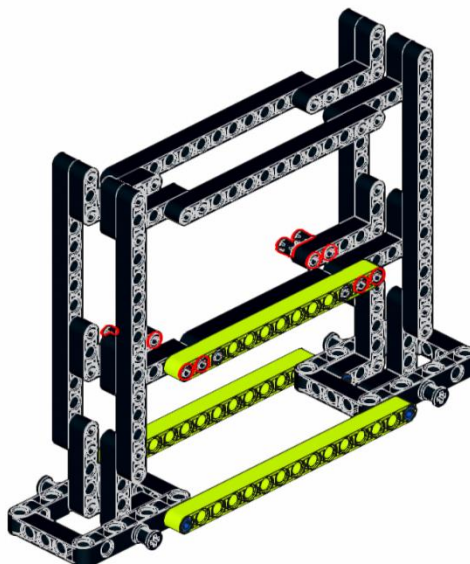
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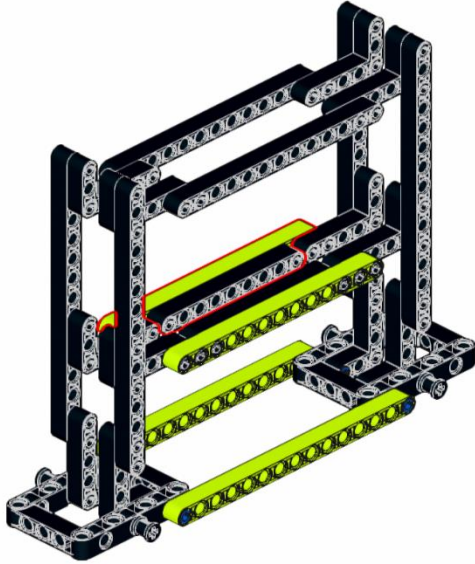
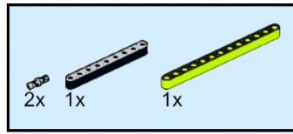
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16

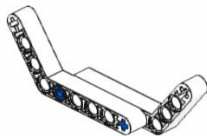
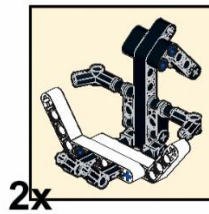
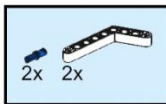


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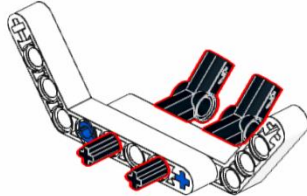


8.4B Hanging Pot

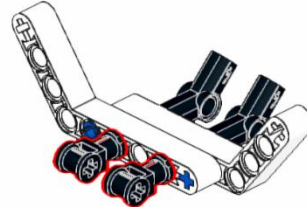
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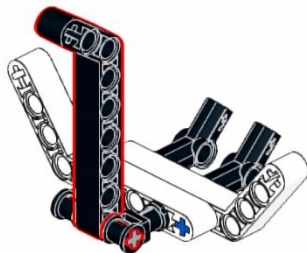
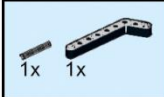
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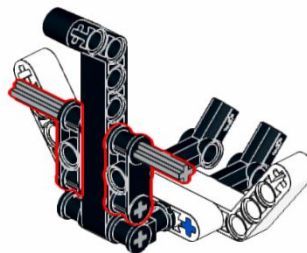
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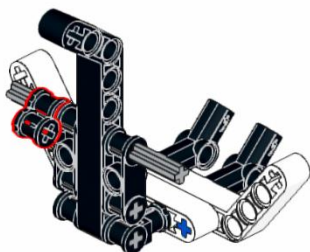
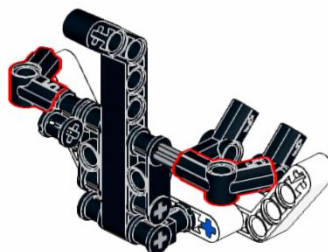
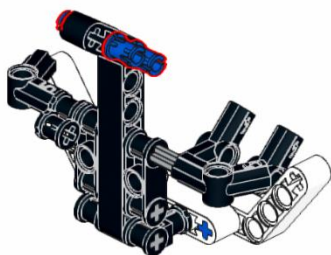
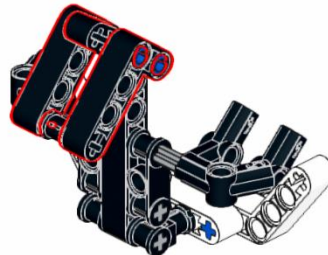


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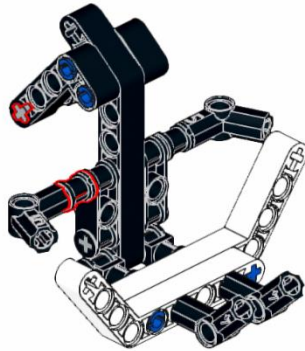
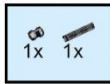


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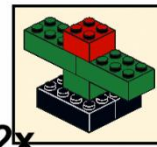
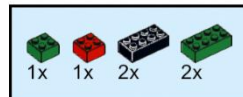
23**24****25****26**

27

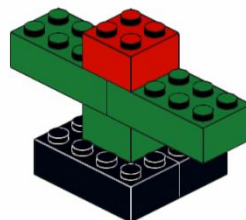


8.4C Red Flower Plant

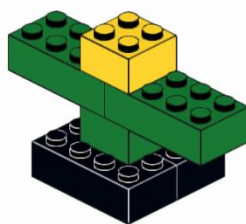
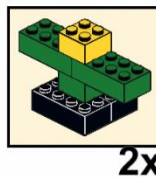
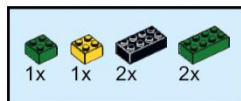
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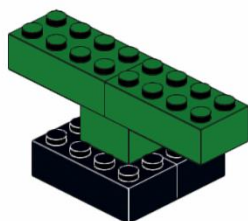
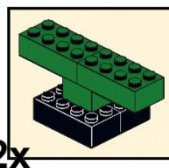
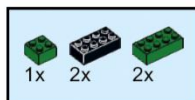
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8.4D Yellow Flower Plant

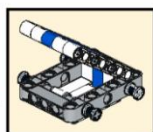
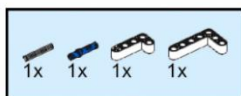
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8.4E Fragile Seedling

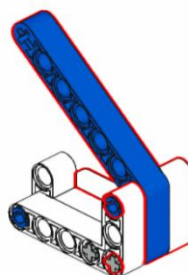
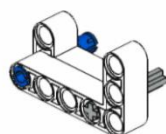
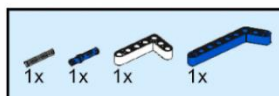
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8.4F Solar Panel

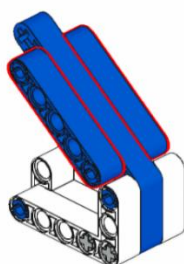
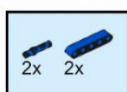
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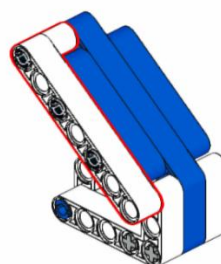
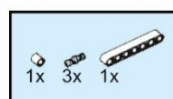
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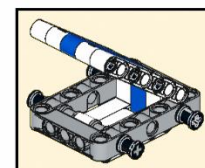
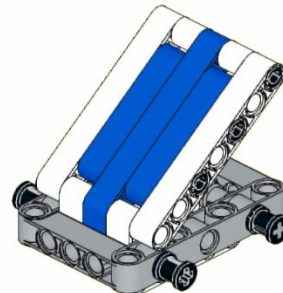
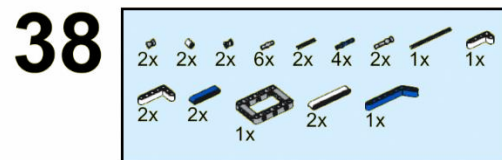
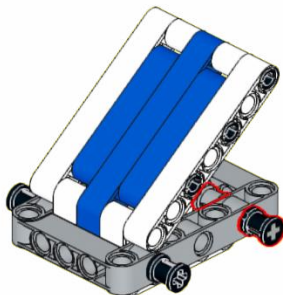
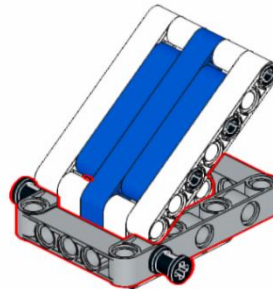
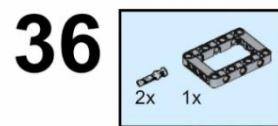
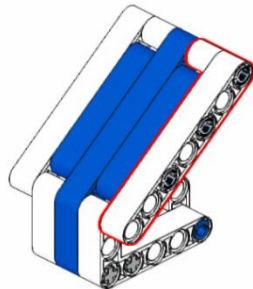


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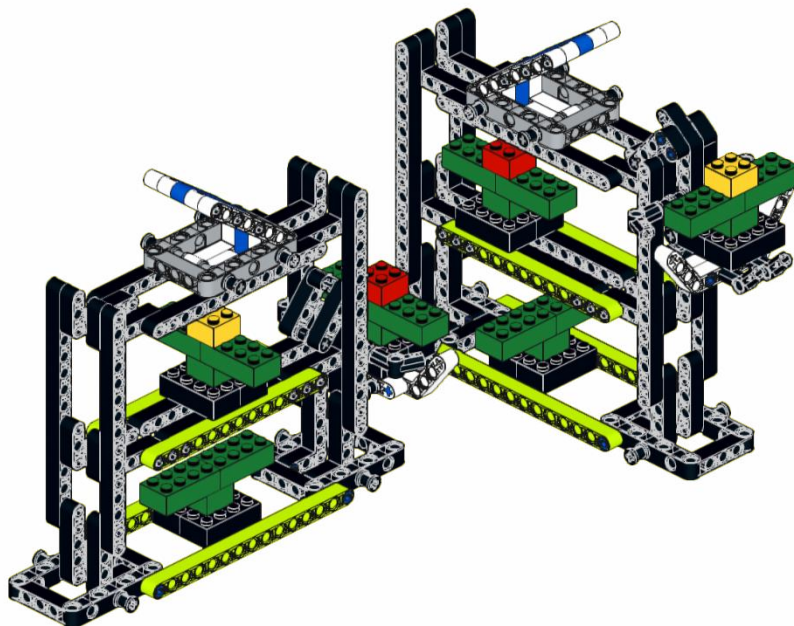


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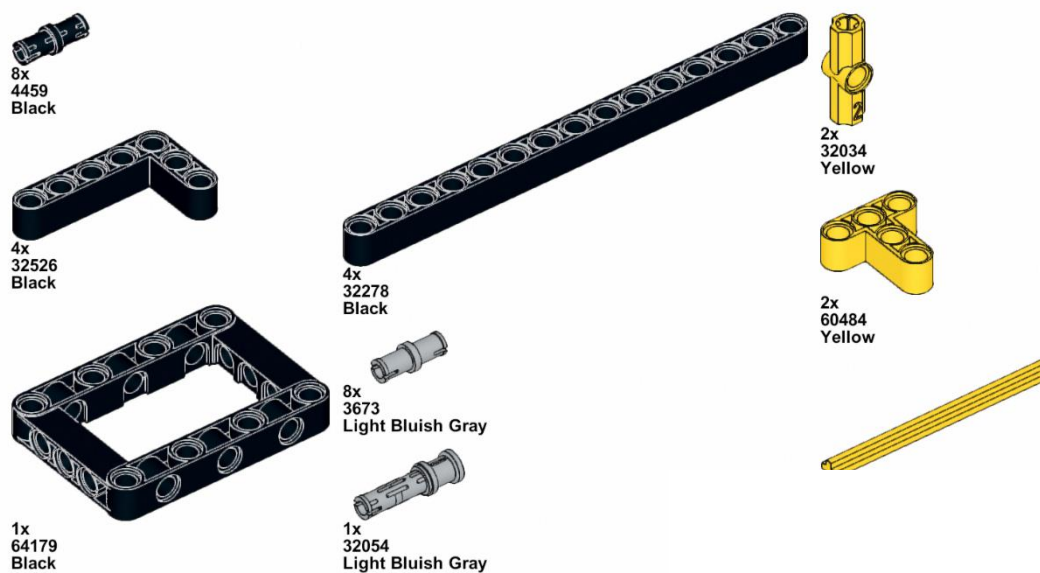


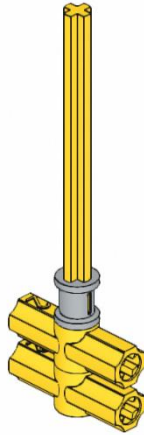
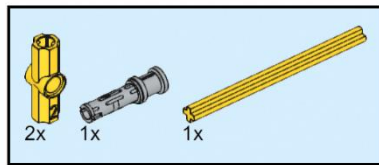
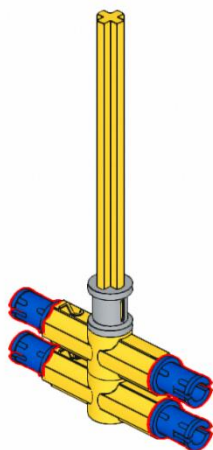
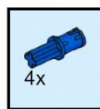
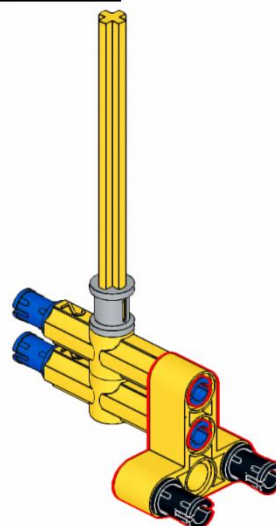
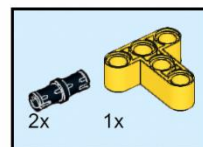


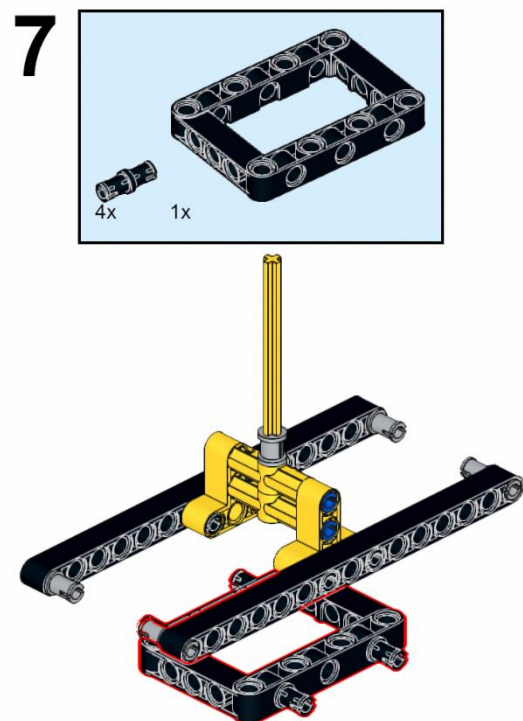
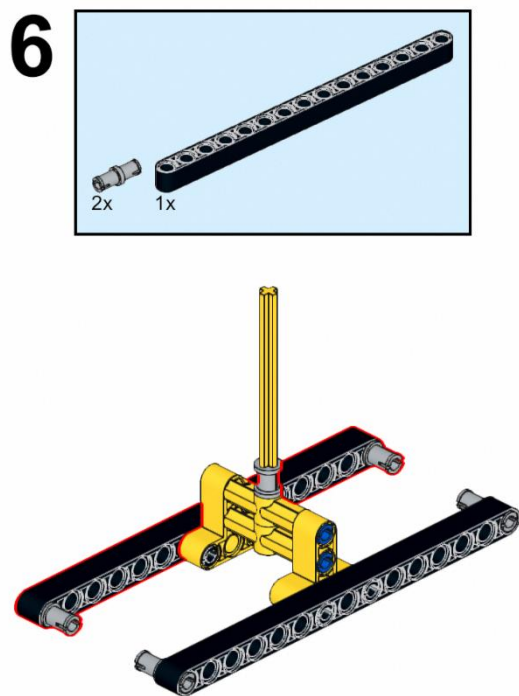
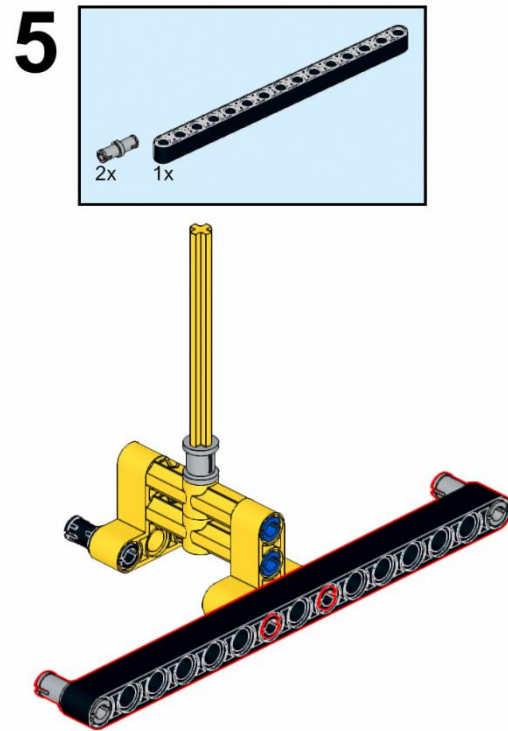
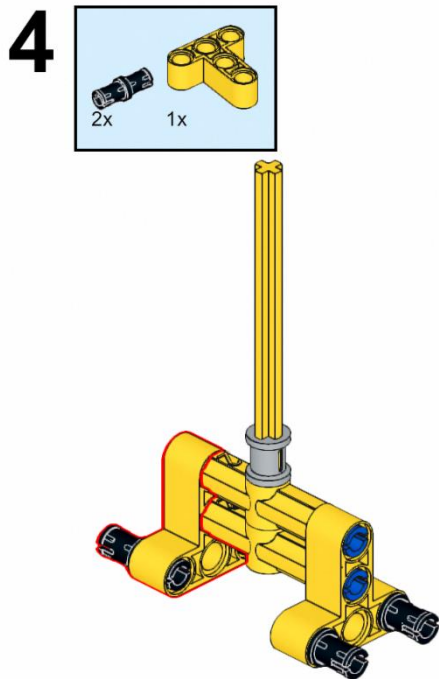
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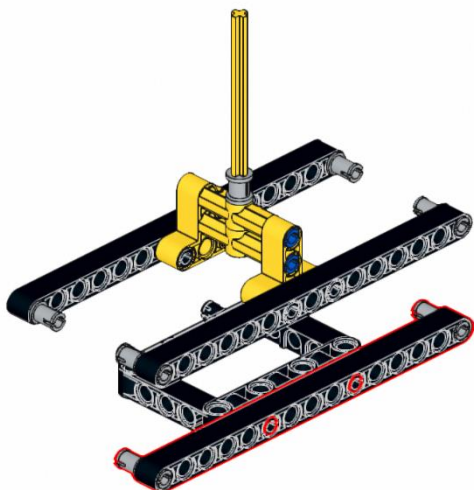
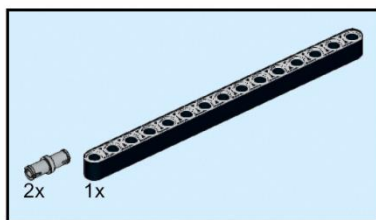
8.5 Return to Charging Station



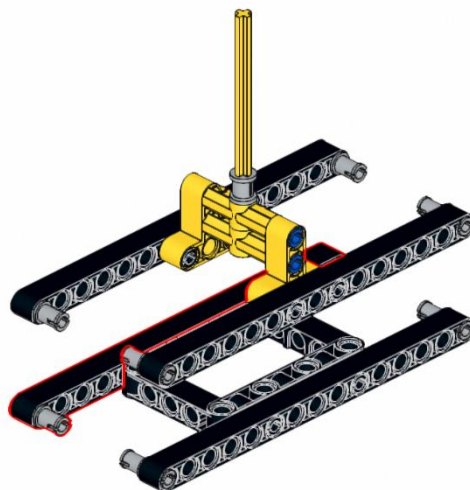
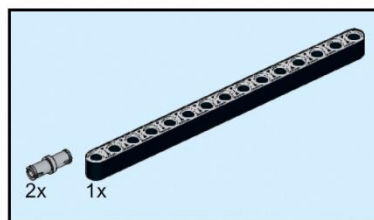
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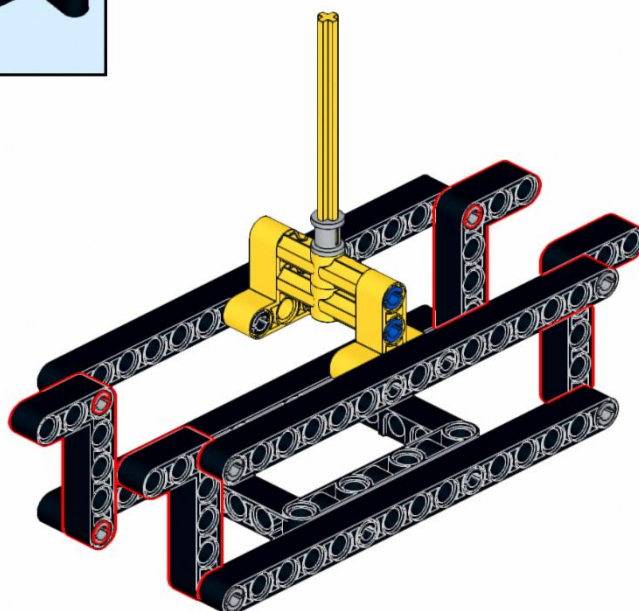
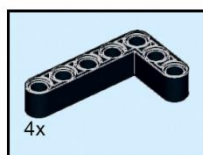
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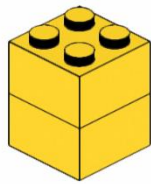
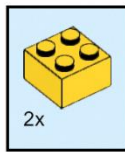
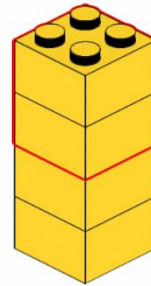
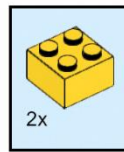
9



10



8.6 Sun Beam

1**2****END**