World Robot Olympiad 2019

Regular Category

Elementary

SMART CITIES

SMART PASSENGER TRANSPORT

Version: January 15th

WRO International Premium Partners

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1. Introduction

Transportation is a fast growing and changing industry in the 21th century. Communication and information technology solutions to transportation challenges appear every day. These changes lead to increasing automation in transport.

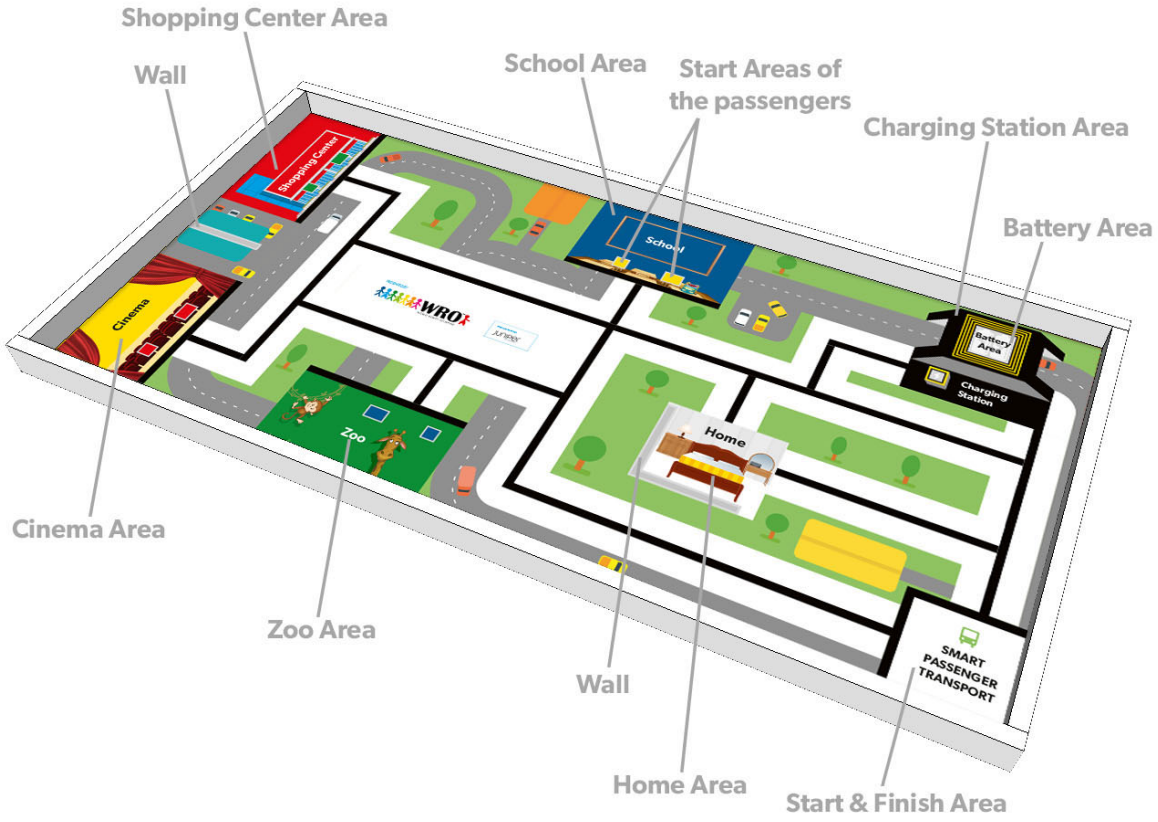
One part of automation in transport is self-driving cars. A self-driving car is able to sense the environment and navigate without human input. Due to robotic control, it can reduce the risk of accidents, avoid traffic jams, and require less driving and parking space. Self-driving cars could replace taxis and public transportation in the future.

Since 2015, Hungary has been actively involved in the development of self-driving vehicles, and in the near future, a modern test track will be finished and ready to start testing advanced technology in a road environment.

This year, it is the mission to build a robot that can act as a real autonomous, self-driving taxi that takes passengers from a starting position to a target area.

2. Game Field

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



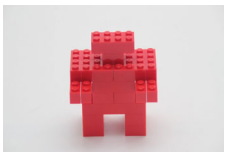
If the table is larger than the game mat, use the start area as a guide and place the Start & Finish Area at the edge of the wall to set up the game mat.

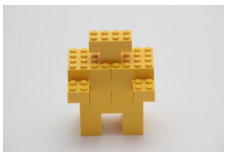
For more information about the table and game mat specifications, please take a look at WRO Regular Category General Rules Rule 4. The printable file of the mat and a PDF with the exact measurements are available on www.wro-association.org.

3. Game Objects

There are **8 colored passengers (green, red, yellow, blue)**, 4 adults and 4 children, and **2 white passengers**, 1 adult and 1 child, on the field. **Note:** Not all passengers are used in one run, please take a look at the next chapter for randomization.


Green adult


Red adult


Yellow adult


Blue adult


White adult


Green child

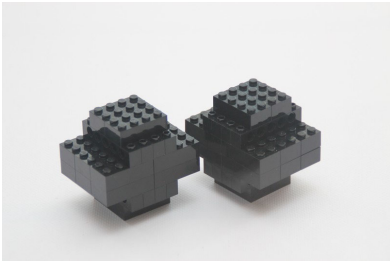

Red child


Yellow child

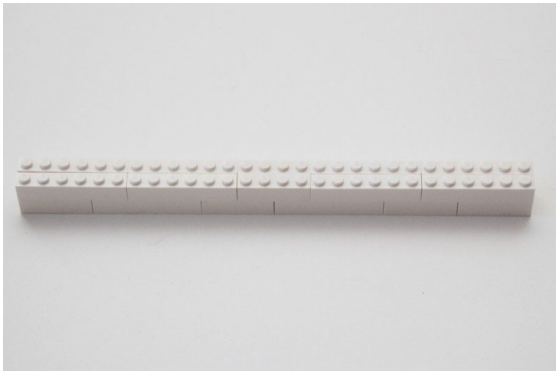

Blue child

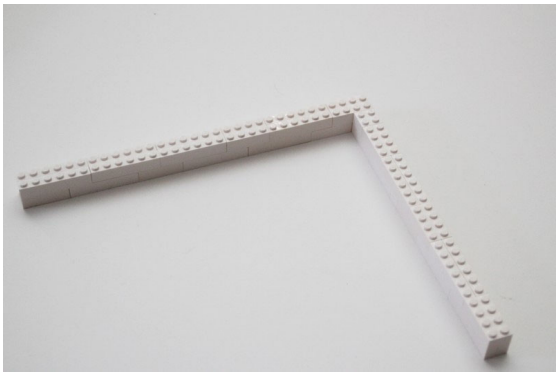

White child

There are **2 battery blocks** on the field.


Battery Blocks

There are **2 walls** on the field. Movement or destruction of walls is not allowed.

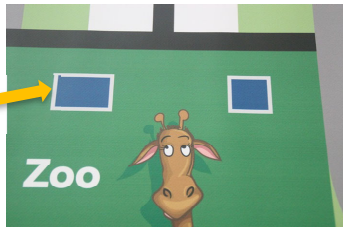

Wall between the red and yellow areas


Wall surrounding the home area

4. Positioning of Game Objects / Randomization

Positioning of the passengers

The positions of the passengers are randomized at the start of each round. The randomization is done in the following steps.



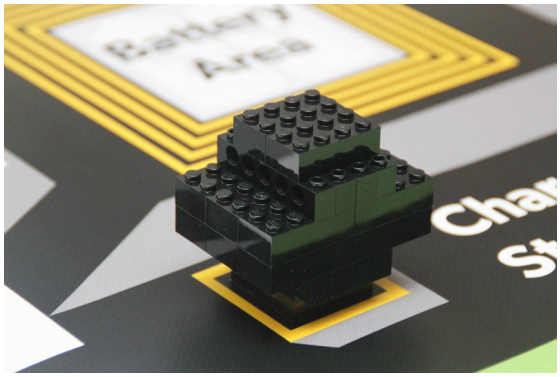
1. **Place all colored passengers** (red, yellow, green and blue) on their start areas (blue passengers in the small blue rectangle on the field, yellow passengers in the yellow rectangle, etc.). The adult passengers are always positioned with their arms pointing into the middle of the playing field. The child passengers are positioned with their arms parallel to the black line at the edge of their area. Please take a look on the photos on this page below.
2. **Draw four colors one by one and change figures accordingly:**
   There are four different colored LEGO elements in a box: red, yellow, green, and blue. Draw them one by one and don't put them back into the box after drawing.
   a. Replace the child of the first drawn colored area with the white child.
      (e.g. you draw "red" first then you replace the red area's child with the white child)
   b. Replace the adult of the second drawn colored area with the white adult.
   c. Remove the child from the third drawn colored area.
   d. Remove the adult from the fourth drawn colored area.

One possible example could look like this:

1. **Place all colored passengers:**

2. **Draw of the colors: Red, Blue, Yellow, Green**
    a. Changed child in RED area to a white child.
    b. Changed adult in BLUE area to a white adult.
    c. Removed the child from the YELLOW area.
    d. Removed the adult from the GREEN area.

Positioning of battery blocks



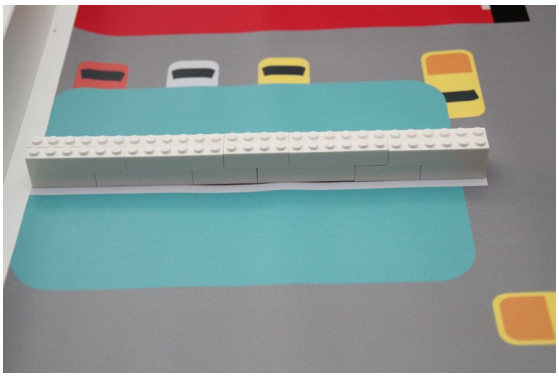
One battery block is placed in the Start & Finish Area. Teams are allowed to put this battery block on their robot before the start.

If the team puts the battery block on the robot, it has to fit into the maximum size of the robot (25cm x 25cm x 25cm). If the team does not want to use the extra battery block, they can put it away.

The other battery block is placed in the small position in the black area (see photo).

Positioning of walls

The walls are placed on the dark grey areas that are exactly the size of each wall. One wall surrounds the home area. The other wall is between the shopping center and cinema area.



5. Robot Missions

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

5.1 Mission: Bring the passengers to their target areas

The robot should bring **the yellow, green, red, and white passengers** to their target areas:

- Yellow passengers
  ➔ Bring to yellow area (Cinema Area, rectangle area including red curtains)
- Green passengers
  ➔ Bring to green area (Zoo Area)
- Red passengers
  ➔ Bring to red area (Shopping Center Area)
- White passengers
  ➔ Bring to white area (Home Area)

A **Blue** passenger (child or adult, depending on the draw) will stay in the zoo the whole day. This passenger should not be moved. It is ok as long as the blue passengers still touch the start rectangle.

For the scoring, only the colored area (not including the black line) counts. Please take a look at the scoring examples after the scoring table for more information.

5.2 Mission: Bring equipment to the charging station

The robot should bring one of the battery blocks to the marked **Battery Area** inside the charging station. The team can decide if they use the battery block in the Start & Finish Area or if they use the battery block placed in the charging station area. Points are awarded if the battery block is completely inside the **Battery Area**.

Only one battery block counts. If the team brings two battery blocks, the one with the highest points will count (e.g. if one battery block is completely inside the Battery Area and the other one only partly, then the battery block that is completely inside the Battery Area will count).

5.3 Mission: Park the robot

Before the start of the run, the robot must start completely within the Start & Finish area (the surrounding line is not included in the Start & Finish Area. At the start, the cables count toward the maximum size of the robots, so they need to be within the Start & Finish Area).

The mission is complete when the robot returns to the Start & Finish area, stops, and the chassis of the robot is entirely (top-view) within the Start & Finish area (cables are allowed to be outside of the Start & Finish area).

5.4 Penalty points (walls)

The walls must not be damaged or moved from the grey area. If the walls are damaged or moved **outside the light grey area**, a penalty is given but will never result in a negative score (see General Rules 6.15).

6. Scoring

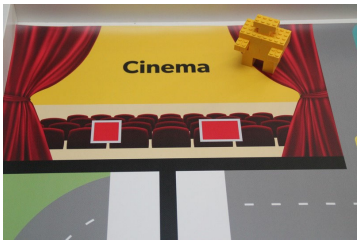
Definitions for the scoring

- **"Standing"** means that the game object is still in upright position (like the initial position). **"Not Standing"** means any other position.
- **"Completely"** means that the game object is only touching the corresponding area (not including the black lines). "**Partly"** means that the game object is at least touching the area with one part.

Tasks	Each	Total
Red / **Yellow** / **Green** / **White** Passenger (adult or child): • **Standing** and in the **correct** target area • **Completely** in the target area	**25**	**125**
Red / **Yellow** / **Green** / **White** Passenger (adult or child): • **Not standing** but in the **correct** target area • **Completely** in the target area	15	75
Red / **Yellow** / **Green** / **White** Passenger (adult or child): • **Standing or not standing** but in the **correct** target area • **Partly** in the target area	5	25
Red / **Yellow** / **Green** / **White** Passenger (adult or child): • **Standing** but in a **different** target area • **Completely** in the target area • that is not the start area of the passenger, not the charging station area, and not the start / finish area of the robot	10	50
Red / **Yellow** / **Green** / **White** Passenger (adult or child): • **Not Standing** and in a **different** target area, • **Completely** in the target area • that is not the start area of the passenger, not the charging station area, and not the start / finish area of the robot	5	25
Blue Passenger (adult or child, depending on draw) still **standing** in initial position in the green area. *(only if points **for other passengers** are assigned)*		**15**
One battery block is **completely** in the Battery Area.		**15**
One battery block is **partly** in the Battery Area.		5
Robot completely stops within the Start & Finish Area. *(only if points **for passengers** are assigned)*		**10**
Robot damages or displaces a wall from its initial position.	-5	-10
Maximum Score		**165**

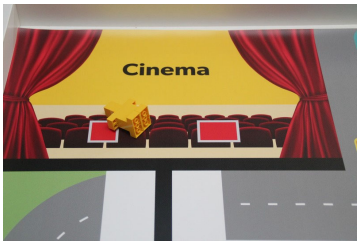
Scoring Interpretation

Standing in the **correct** target area, **Completely** in the target area ➔ 25 points

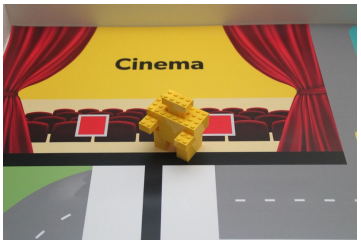


This is fine as well. The red curtain belongs to the yellow cinema area.

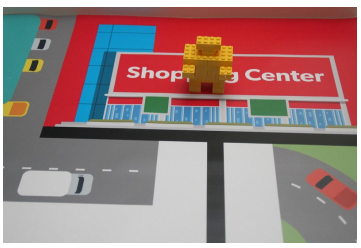
Not standing in the **correct** target area, **Completely** in the target area ➔ 15 points

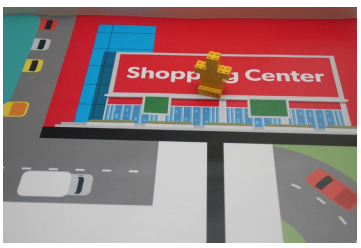


Standing or not standing in the **correct** target area, **Partly** in the target area ➔ 5 points

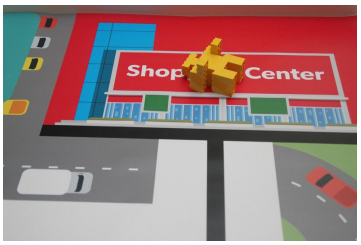


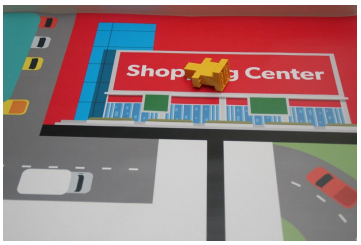
Standing in a **different** target area, **Completely** in the target area ➔ 10 points





Not Standing in a **different** colored area, **Completely** in the area ➔ 5 points

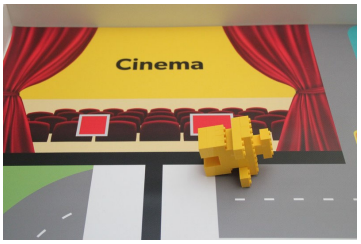




Please remember: "that is not the start area of the passenger, not the charging station area, and not the start / finish area of the robot"

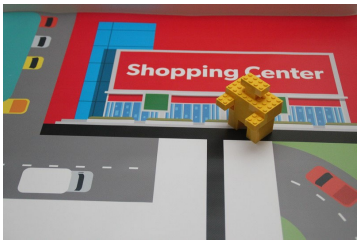
Incorrect tasks: For all these situations you get <u>no (ZERO) points</u>

Not in the area



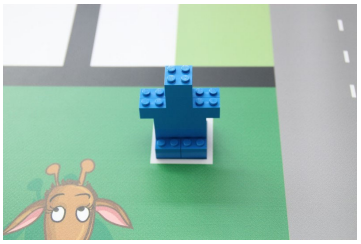
Not in the area (only touching the black line)

Passenger is damaged

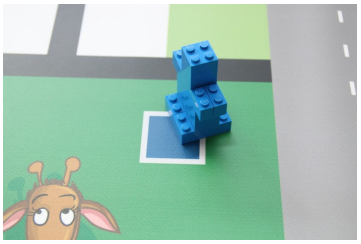


Partly in a different area

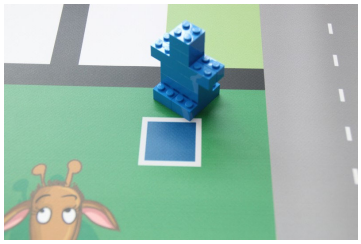
Blue Passenger (adult or child, depending on draw) still **<u>standing</u>** in starting position in the green area. *(only if points **for other passengers** are assigned)* ➔ 15 points



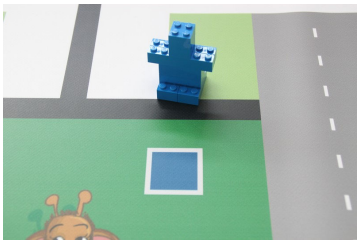
Standing in start position



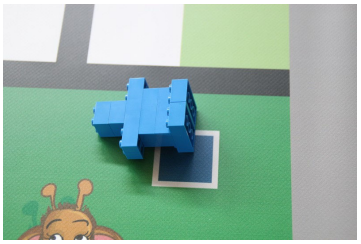
Touching blue rectangle is OK



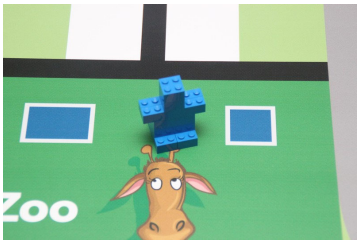
Touching the surrounding grey line is OK as well



No points if the passenger is outside the rectangle



No points if the passenger is not standing anymore



No points if the passenger does not touch the initial position

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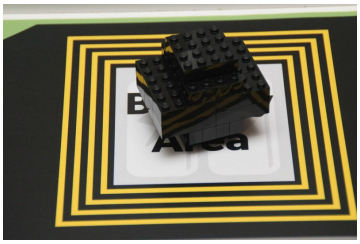
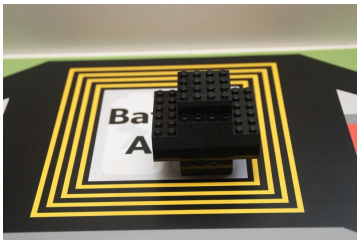
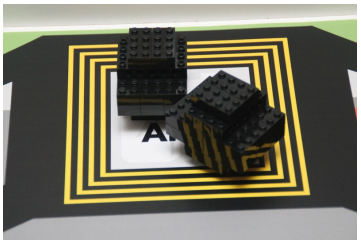
One battery block is **completely** in the Battery Area ➔ 15 points



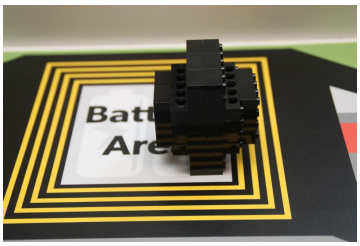
The Battery Area is the inner grey rectangle without any surrounding lines.



In this case “completely” means the parts of the block that touch the mat are inside the area. That is ok.

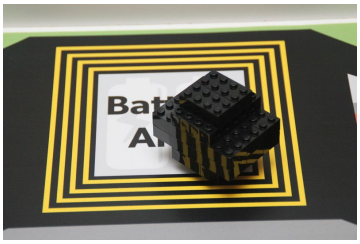


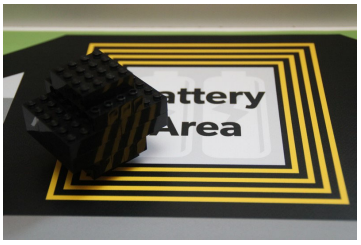
Only one block, the block with higher points, counts (in this case the one that is completely inside).



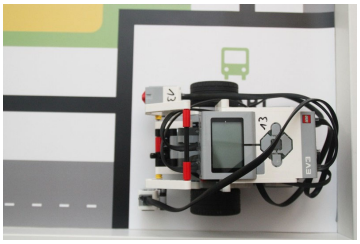
It is ok if the block is lying on the side. What is important is that all parts that touch the mat are inside the area.

One battery block is **partly** in the Battery Area.➔ 5 points

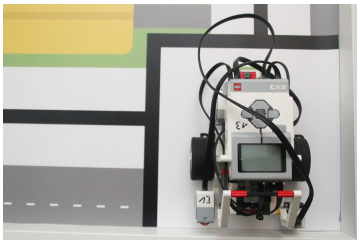




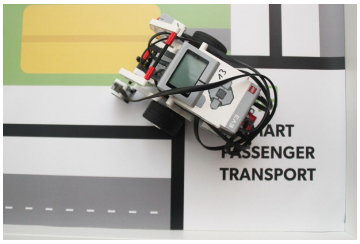
Robot completely stops within the Start & Finish Area. ➔ 10 points
*(only if other points **for passengers** are assigned)*



The projection of the robot is completely inside the start/finish area. Well done ☺.



The projection of the robot is completely inside, and cables are out. That is still OK.



No points if the projection of the robot is not in the start/finish area.

Penalty points: The robot damages or displaces the wall from its initial position.➔ **-5 points**

It is OK if a wall is moved inside the light grey area.

Penalty points if a wall is outside the grey area.

Penalty points if a wall is damaged.

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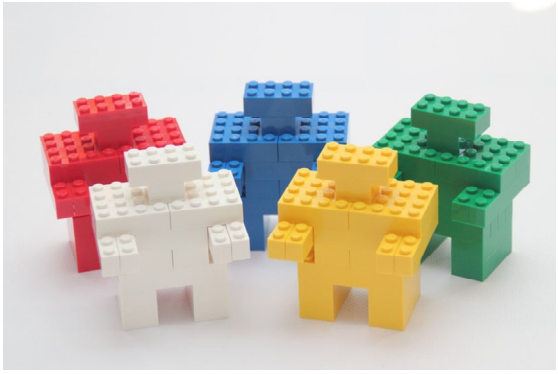
7. Assembly of Game Objects

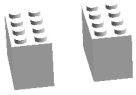
Assembly of the passengers



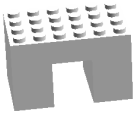
There are 5 adults, one white, one blue, one yellow, one red, and one green.

For **one adult** you need:

- 1 2x2 bricks
- 8 1x6 bricks
- 13 2x4 bricks

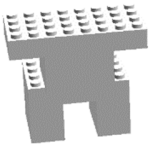


Step 1

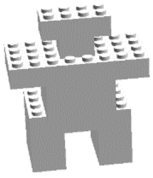


Step 2

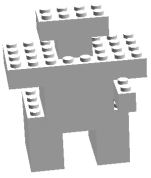
Step 3



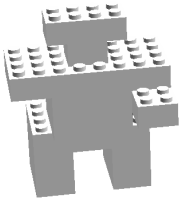
Step 4



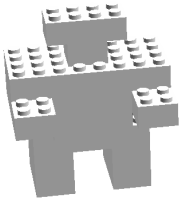
Step 5



Step 6



Step 7

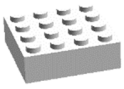


Step 8

There are 5 children, one white, one blue, one yellow, one red, and one green.

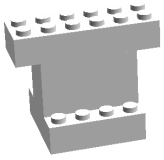
For **one child** you need:

- 4 2x4 bricks
- 2 1x6 bricks
- 2 2x2 bricks

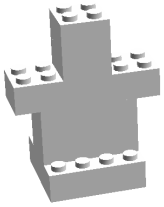


Step 1

Step 2

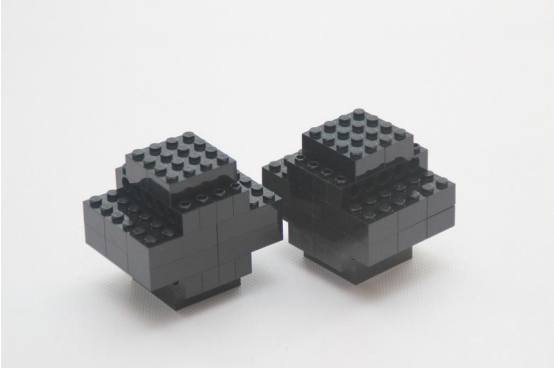


Step 3



Step 4

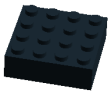
Assembly of the battery blocks



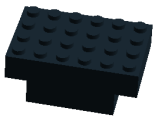
The two battery blocks are built out of black LEGO bricks.

For **one battery block** you need:

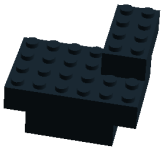
- 16 black 2x4 bricks
- 8 black 1x6 bricks



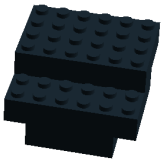
Step 1



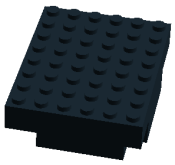
Step 2



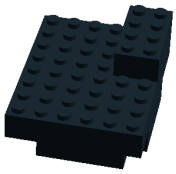
Step 3



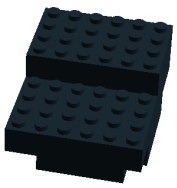
Step 4



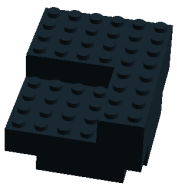
Step 5



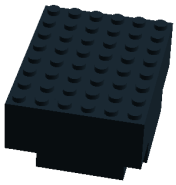
Step 6



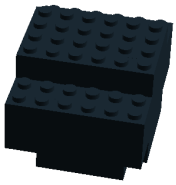
Step 7



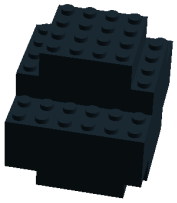
Step 8



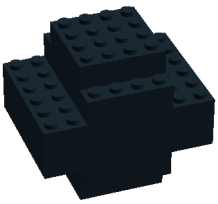
Step 9



Step 10



Step 11



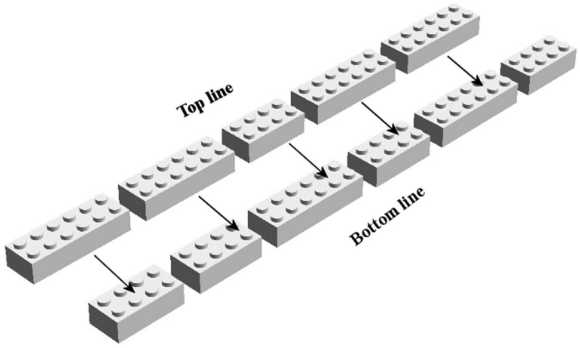
Battery Block

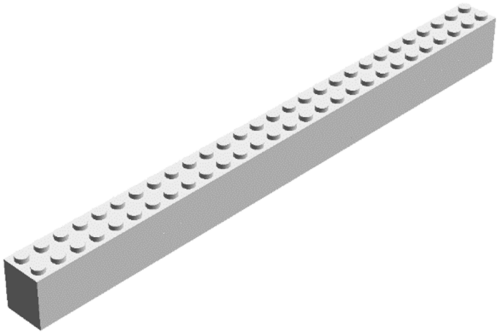
Assembly of the walls

Both walls are built out of white LEGO bricks.

Wall between the red and yellow areas

For this wall you need 5 white 2x4 bricks and 12 white 1x6 bricks.





Wall surrounding the home area

For this wall you need 9 white 2x4 bricks, 26 white 1x6 bricks and 1 white 2x2 brick.