

**FIRST  
LEGO  
LEAGUE**

**CHALLENGE**

# ROBOT GAME RULEBOOK







**FIRST® LEGO® League**  
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The **LEGO** Foundation



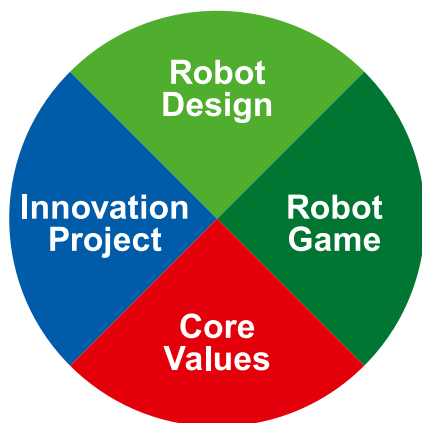
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# Introduction

Welcome to *FIRST*® ENERGIZE<sup>SM</sup> presented by Qualcomm. This year's *FIRST*® LEGO® League Challenge is called **SUPERPOWERED<sup>SM</sup>**. Your team will work together on many different tasks in preparation for an incredible experience at your tournament.



Each of these four equally weighted parts of *FIRST* LEGO League Challenge accounts for 25 percent of your total performance.

Find out more in the *Engineering Notebook*. It guides teams through their journey. It provides inspiration for the Innovation Project through the Project Sparks.

Teams can use the LEGO® Education SPIKE™ app to learn how to build and code their robot. Also, the guided mission provides the program needed to complete Mission 05 Smart Grid.

## SUPERPOWERED<sup>SM</sup> Robot Game

This season's game is about collecting energy units from different sources around the field and distributing them to where the energy will be stored

or consumed. Points are scored for releasing energy units from the models and delivering energy units to target destinations.





# How to Get Started

1. Build your mission models using the **Mission Model Building Information** ([p. 22-23](#)).



2. Decide whether to put your field mat on a table or on the floor. Instructions to build your own table can be found on [p. 24](#).



3. Follow the field setup instructions on **Field Mat Placement** ([p. 24](#)), **3M™ Dual Lock™ Reclosable Fastener Placement** ([p. 25](#)), and the **Mission Model Setup** ([p. 26-28](#)).

4. Learn how to play! Read the **Rules** ([p. 16-21](#)) and **Missions** ([p. 7-15](#)) and watch the season videos.



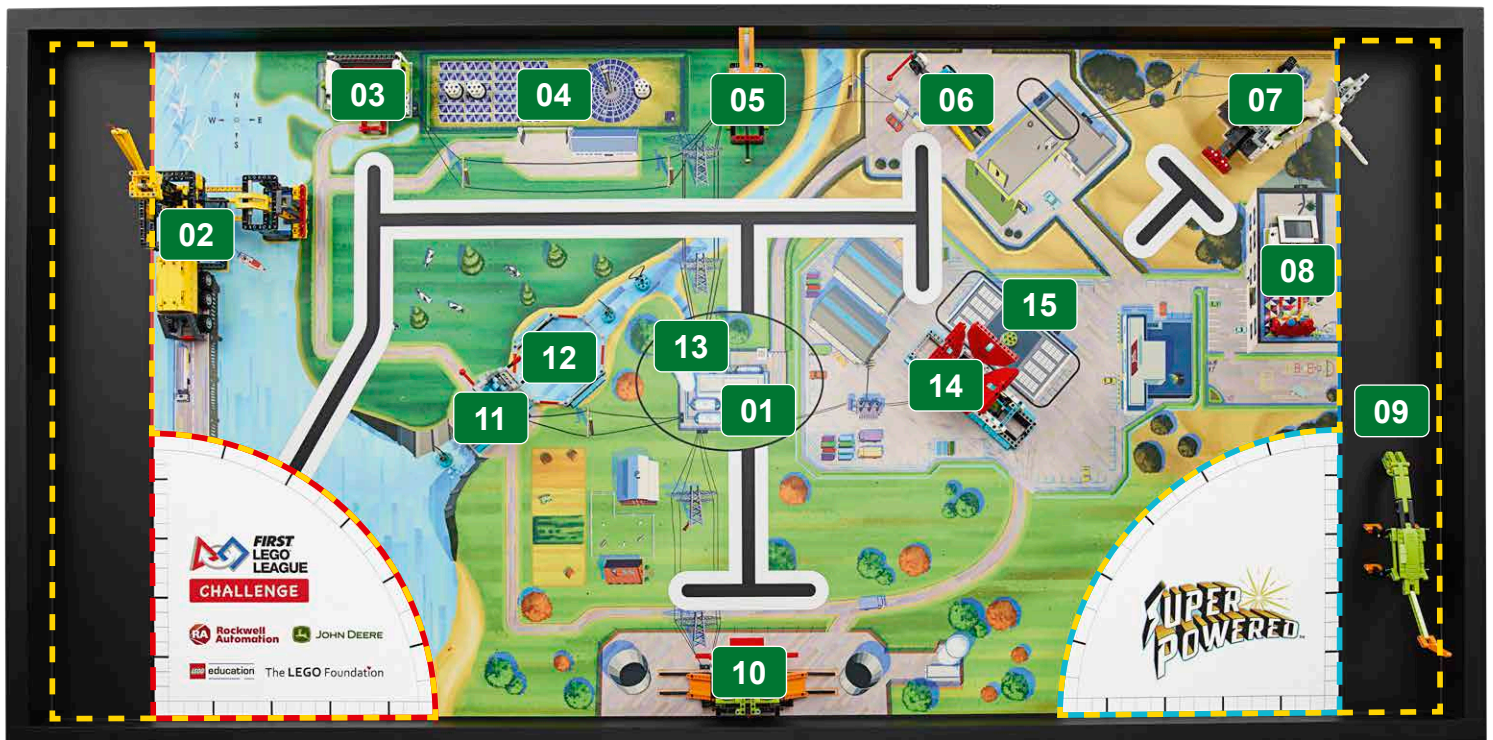
5. Check out what is **New This Year** ([p. 16](#)), read the **Robot Game Guiding Principles** ([p. 6](#)), and monitor any challenge updates online.



6. Review this guide. You will find useful resources like a **Glossary** ([p. 16](#)), **Robot Path Diagram** ([p. 29](#)), and **Scoresheet** ([p. 30-31](#)).

For a fully guided experience of the *FIRST® LEGO® League Challenge*, students can refer to the *Engineering Notebook* and the facilitator can use the *Team Meeting Guide*.

See where missions are located on the field as shown by the mission numbers below.



Left Home

Left Launch Area

Right Launch Area

Right Home

# Robot Game Guiding Principles

1. The team works together to design and build a LEGO® robot and then program it to complete a series of missions autonomously to score points in a 2.5-minute Robot Game match.
2. The team launches their robot from one of the two launch areas, and it moves around the field attempting to complete the missions in the order chosen by the team.
3. The robot is programmed to return to either home area at any time. The team can modify it while it is in a home area before launching again to try other missions.
4. The team starts the match with six precision tokens worth points. If needed, the robot can be brought back to home by hand, but the team will lose a token for the interruption.
5. During a match, only the robot can move objects from one home area to another. When a robot is interrupted, it can be returned to either area.
6. Mission requirements must be visible at the end of the match to score unless otherwise stated in the mission.
7. The team will have three matches, but only their highest score will count.
8. The team expresses Core Values through *Gracious Professionalism*®. Referees will assess the team's *Gracious Professionalism* at every match.

## Gracious Professionalism®

### Gracious Professionalism displayed at the robot game table

Referees will evaluate *Gracious Professionalism* for every team at each one of their matches.

The *Gracious Professionalism* points will be added to the points scored on the Core Values rubric during the judging session and will make up a portion of the total Core Values score.

It will be assumed that every team will start with *Gracious Professionalism* that is **ACCOMPLISHED** (3 points). If a referee observes behavior that is above and beyond what is expected, they will score the team's *Gracious Professionalism* as **EXCEEDS** (4 points). Equally, if a team's behavior shows that their *Gracious Professionalism* is still evolving, they will be scored as **DEVELOPING** (2 points).

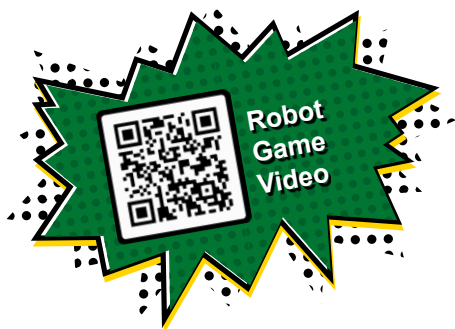
DEVELOPING	ACCOMPLISHED	EXCEEDS
2	3	4

If a team does not show for their match, they will score no points for *Gracious Professionalism*. However, if a team arrives and does not run the robot but does explain what has happened, they can get a

*Gracious Professionalism* score of 2, 3, or 4 points depending on the *Gracious Professionalism* they demonstrate.

# Missions

Now it's time to play the SUPERPOWERED<sup>SM</sup> robot game! Missions are tasks that can be completed for points. The missions are explained in this section, which should be read by the team as they stand next to the field.



Some missions are grouped into Energy Journeys which are referred to on page 9 of the *Engineering Notebook*.



White Energy Journey - referred to in Session 1



Blue Energy Journey - referred to in Session 2



Yellow Energy Journey - referred to in Session 3



Orange Energy Journey - referred to in Session 4

Check your score using the Official Scoring Calculator.



Before the match, the referee will carry out an equipment inspection.



## EXAMPLE MISSION LAYOUT

*Model Picture*

*Field Location*

The story or background behind the mission

Basic description of each Mission (Not used for scoring)

- Regular black text under the mission description lists the main requirements: **XX points are in bold red.**
- If the referee sees these things performed or completed: **XX points as described.**

*Blue italic text is for very important added requirements, leniency, or other helpful facts.*

*Sometimes, pictures teach you with an example score.*

**XX points are in bold red.**

*Sometimes, a picture has a description to help explain it.*

**XX points are in bold red.**

*The pictures may not show you all the scoring possibilities, just some examples!*

**XX points are in bold red.**

## SUPERPOWERED<sup>SM</sup> Missions

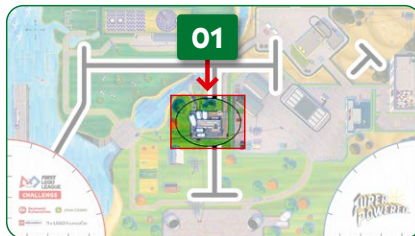
### EQUIPMENT INSPECTION

If your robot and all your equipment fit completely in one launch area and are under a height limit of 12 in. (305 mm) during the pre-match inspection: **20**

*(See Rules, Match Setup 1)*



## Mission 01 INNOVATION PROJECT MODEL



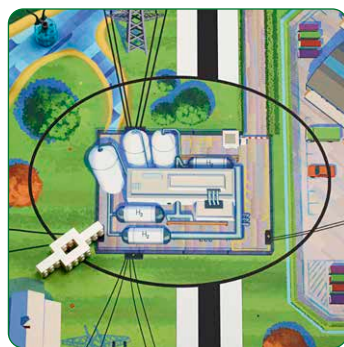
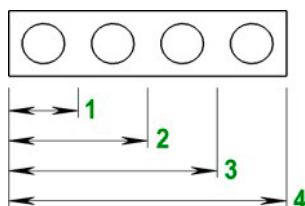
This model should represent the solution to your Innovation Project.

Deliver your Innovation Project model to the hydrogen plant target area.

- If your Innovation Project model is at least partly in the hydrogen plant target area: **10**

*Design and bring a single Innovation Project model of your own to the match. To score, it must:*

- *Be made of at least two white LEGO® pieces.*
- *Measure at least as long as four LEGO studs in some direction.*



**10**



**10**

## Mission 02 OIL PLATFORM



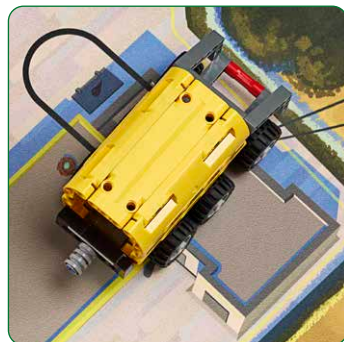
Oil is a non-renewable energy source that can be used to provide fuel for vehicles.

Pump the oil so that the fuel units load into the fuel truck, and then deliver the fuel truck to the fueling station.

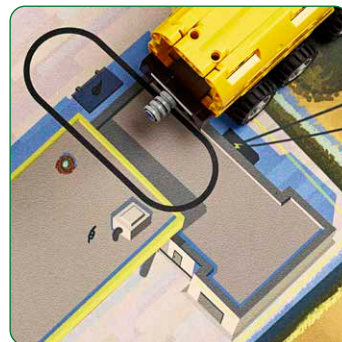
- If a fuel unit is in the fuel truck: **5 EACH**
- Bonus: If at least one fuel unit is in the fuel truck and the fuel truck is at least partly over the fueling station target: **10 ADDED**



**5 + 5**



**5 + 10**  
(1 fuel unit inside)



**5 + 5 + 5 + 10**  
(3 fuel units inside)



## Mission 03 ENERGY STORAGE

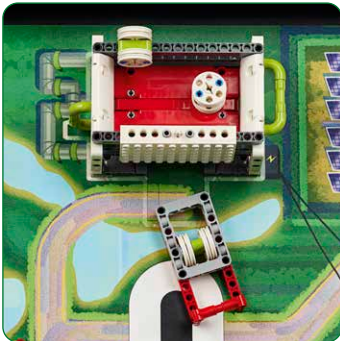


New technologies help us to store energy. Volcanic rocks can be heated in an insulated enclosure to store energy until it is needed.

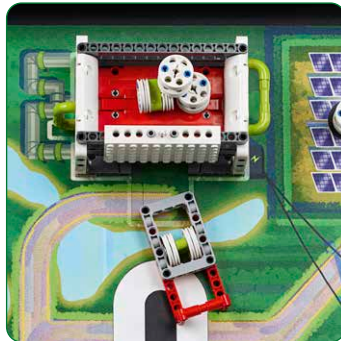
Load energy units into the energy storage bin and then release the stored energy unit from the tray under the model.

- If an energy unit is completely in the energy storage bin (max of three): **10 EACH**
- If the energy unit is completely removed from the energy storage tray: **5**

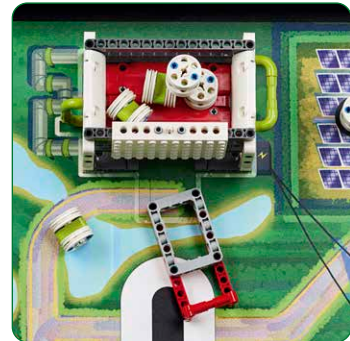
*All energy units stored in the energy storage bin may not be touching team equipment at the end of the match.*



**10**

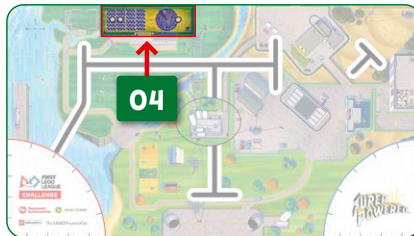
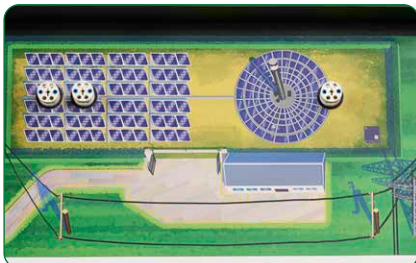


**10 + 10 + 10**



**10 + 10 + 10 + 5**

## Mission 04 SOLAR FARM



Solar energy can be stored using new concentrating solar power technologies and then used to generate electricity.

Start the distribution of the energy units by moving them off their positions on the mat.

- If an energy unit has been completely removed from its starting circle: **5 EACH**
- Bonus: If all three energy units have been completely removed from their starting circles: **5 ADDED**



**5**

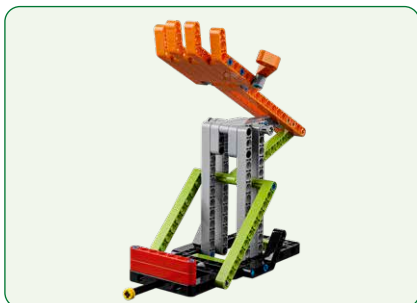


**5 + 5**



**5 + 5 + 5 + 5**

## Mission 05 SMART GRID



Smart grids use electricity generated from all the different energy sources and distribute it to the consumer where and when it is needed.

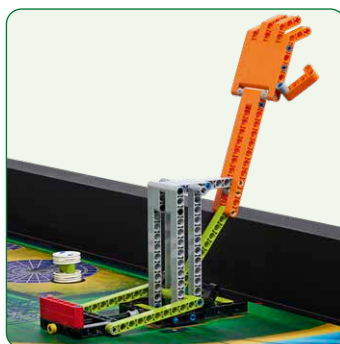
Raise your field's orange connector to complete the smart grid connection with the opposite field.

- If your field's orange connector is completely raised: **20**
- Bonus: If both teams' orange connectors are completely raised: **10 ADDED**

*The smart grid model may not be touching team equipment at the end of the match.*



**0**

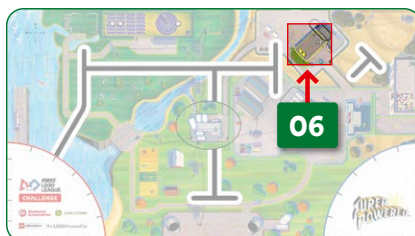


**20**



**20 + 10**

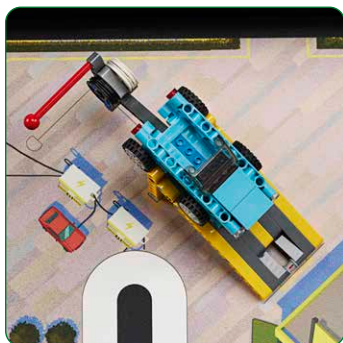
## Mission 06 HYBRID CAR



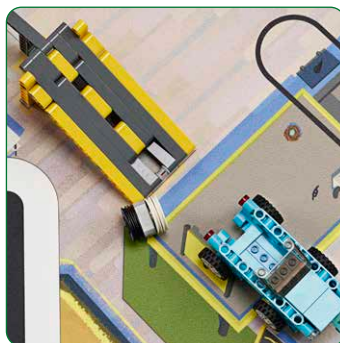
Hybrid cars use a combination of energy sources and can recharge or refuel at the fueling station.

Recharge the hybrid car by inserting the hybrid unit into the car.

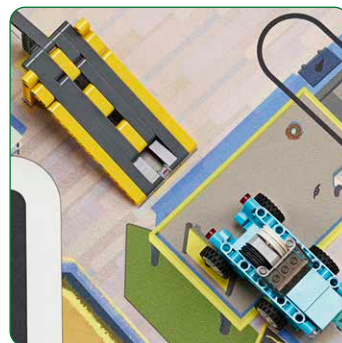
- If the hybrid car is no longer touching the ramp: **10**
- If the hybrid unit is in the hybrid car: **10**



**0**



**10**



**10 + 10**



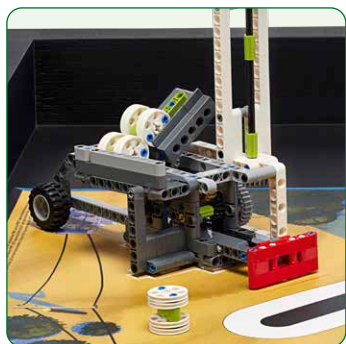
## Mission 07 WIND TURBINE



Renewable energy from the wind is used to turn the turbine blades and generate electricity.

Release the energy units from the wind turbine.

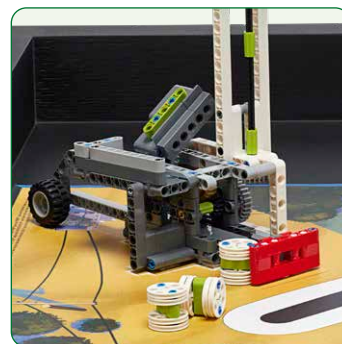
- If an energy unit is no longer touching the wind turbine: **10 EACH**



**10**

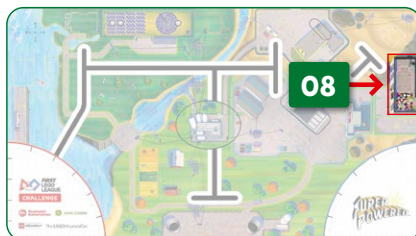


**10 + 10**



**10 + 10**

## Mission 08 WATCH TELEVISION

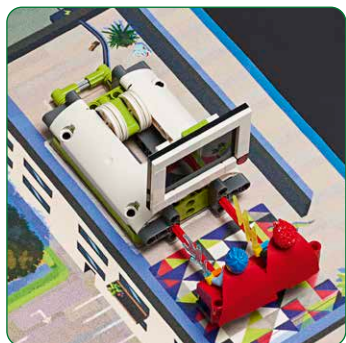


Energy consumption in our homes is part of everyday life, such as watching the television.

Raise the television screen and move the energy unit to the television slot.

- If the television is completely raised: **10**
- If an energy unit is completely in the green television slot: **10**

*The watch television model and the energy unit in the green television slot may not be touching team equipment at the end of the match.*



**10**



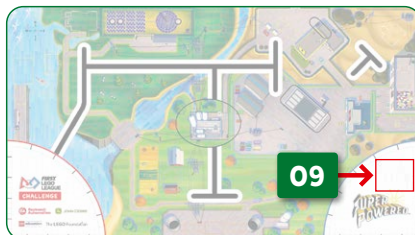
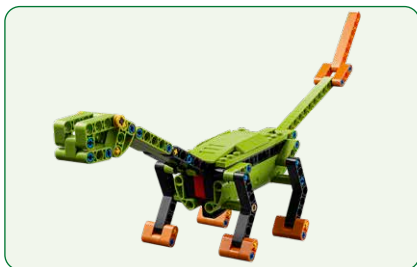
**10**



**10 + 10**



## Mission 09 DINOSAUR TOY



Electronic devices like toys require energy to work. Rechargeable batteries are a more sustainable choice than disposable batteries.

Insert an energy unit or a rechargeable battery into the dinosaur toy to make it work.

- If the dinosaur toy is completely in the left home area: **10**
- If the dinosaur toy lid is completely closed:
  - And there is an energy unit inside: **10**
  - Or there is a rechargeable battery inside: **20**



**10**  
(Empty)

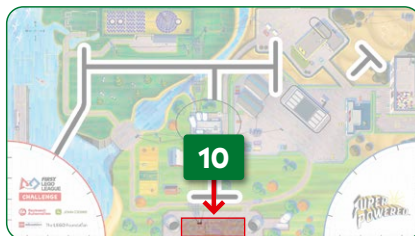
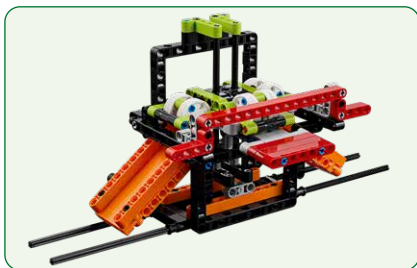


**20**  
(Rechargeable battery inside)



**10**  
(Energy unit inside)

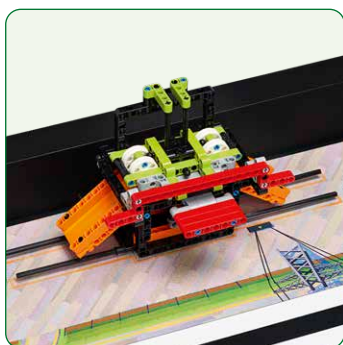
## Mission 10 POWER PLANT



Demand for energy is very high, and many different energy sources can be used to meet that demand.

Release the three energy units from the power plant.

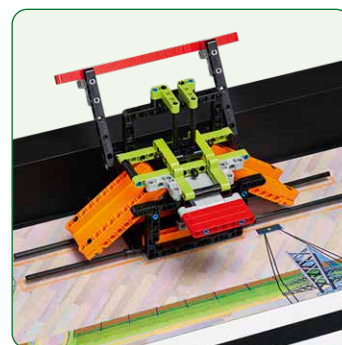
- If an energy unit is no longer touching the power plant: **5 EACH**
- Bonus: If all three energy units are no longer touching the power plant: **10 ADDED**



**5**

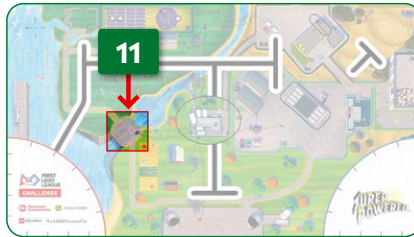
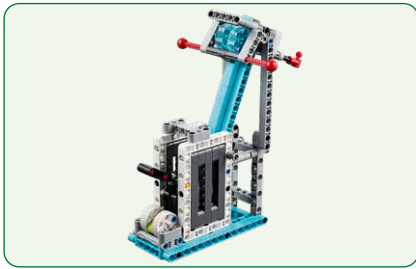


**5 + 5**



**5 + 5 + 5 + 10**

## Mission 11 HYDROELECTRIC DAM



Water released from the reservoir turns the turbine wheel to generate electricity.

Send the water unit from the top of the hydroelectric dam into the turbine wheel to release the energy unit.

- If the energy unit is no longer touching the hydroelectric dam: **20**



0

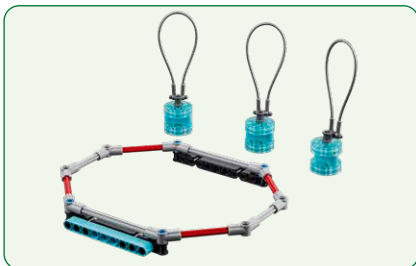


0



20

## Mission 12 WATER RESERVOIR



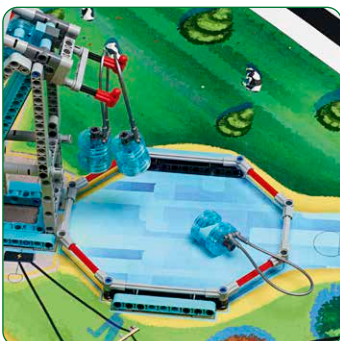
Water from the river above the dam is stored in the reservoir. Water from lower down the river can also be pumped back up to fill the reservoir at times when there is excess electricity to use.

Place the looped water units from the river above and below the dam into the water reservoir or onto the red hooks.

- If a looped water unit is completely in the water reservoir, touching the mat: **5 EACH**
- If a looped water unit is placed on a single red hook: **10 EACH HOOK**

*The loop on the looped water unit may extend out of the water reservoir.*

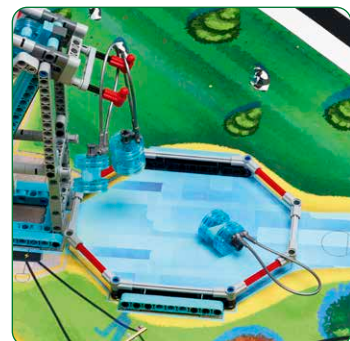
*Looped water units in the water reservoir or on red hooks may not be touching team equipment at the end of the match.*



5 + 10



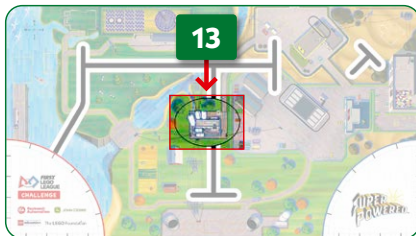
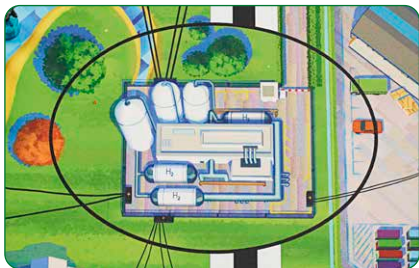
5 + 10



5 + 10



## Mission 13 POWER-TO-X



Surplus renewable energy can be used to convert water into hydrogen gas that can be stored in tanks until it is needed.

Deliver energy units to the hydrogen plant target area.

- If an energy unit is completely in the hydrogen plant target area (max of three): **5 EACH**



**5 + 5**



**5 + 5 + 5**



**5 + 5 + 5**



## Mission 14 TOY FACTORY

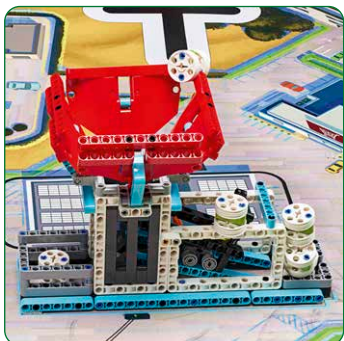


Factories use large amounts of energy to make the products we use such as toys.

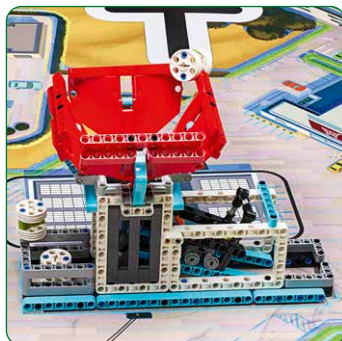
Deliver energy units to the toy factory bin and release the mini dinosaur toy.

- If an energy unit is at least partly in the slot in the back of the toy factory (or in the red hopper) (max of three): **5 EACH**
- If the mini dinosaur toy has been released: **10**

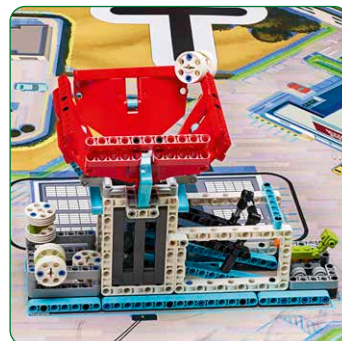
*Energy units stored in the toy factory may not be touching team equipment at the end of the match.*



**5 + 5**



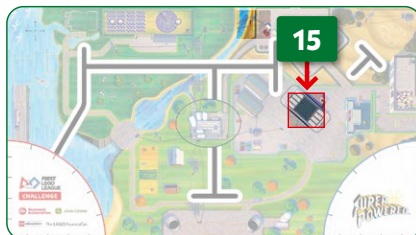
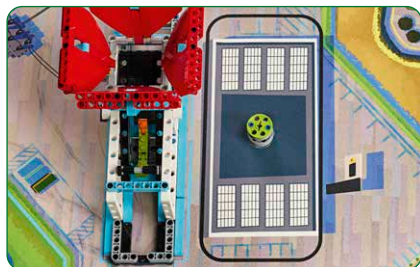
**5 + 5 + 5**



**5 + 5 + 5 + 10**



## Mission 15 RECHARGEABLE BATTERY



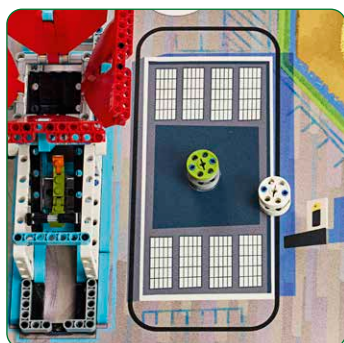
Power can be stored in batteries, but it takes a lot of energy to produce them.

Deliver energy units to the rechargeable battery target area.

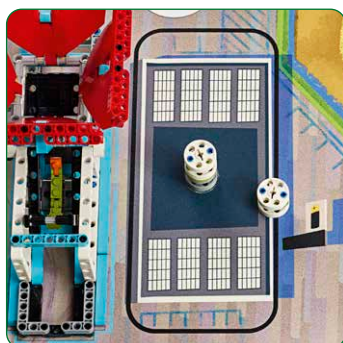
- If an energy unit is completely in the rechargeable battery target area (max of three): **5 EACH**

*The rechargeable battery is not an energy unit.*

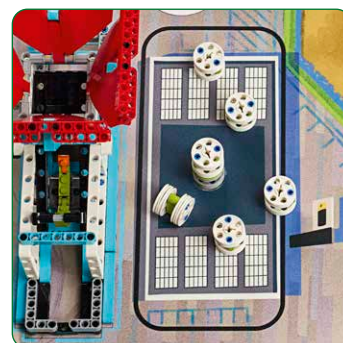
*Energy units stored in the rechargeable battery target area may not be touching team equipment at the end of the match.*



0



5



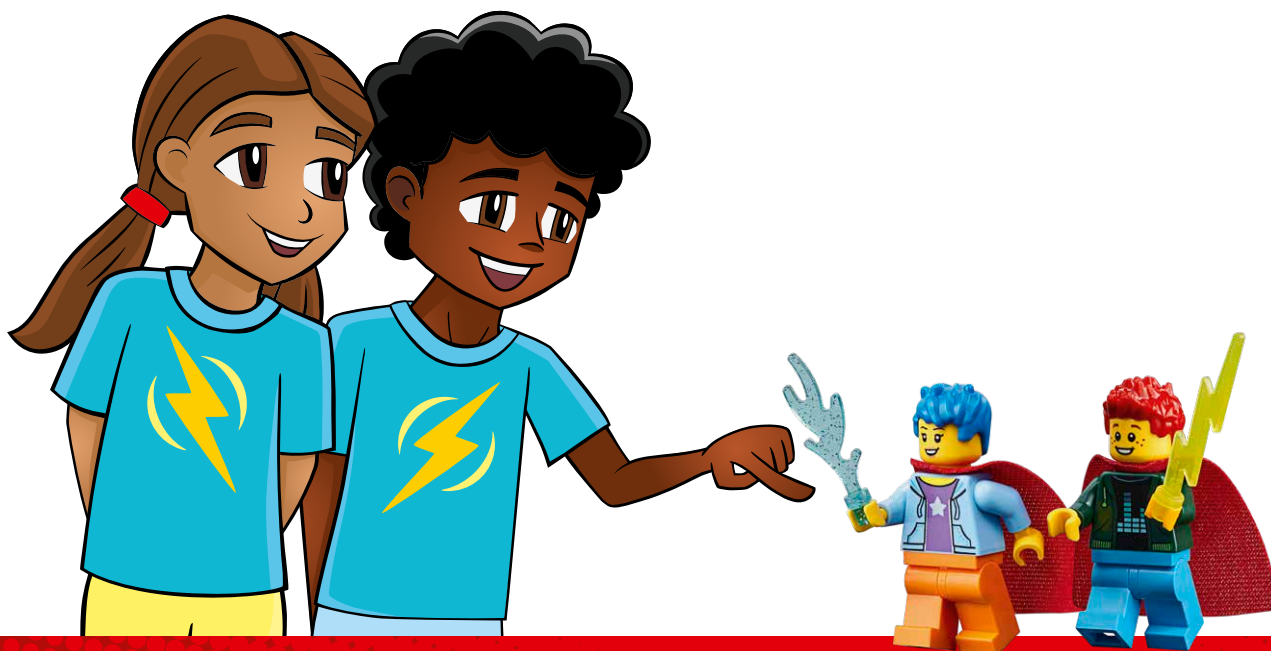
5 + 5 + 5

## PRECISION TOKENS

You begin the match with six precision tokens worth 50 free points. The referee holds onto them. If you interrupt the robot outside of home, the referee removes one token. You keep points for the number of remaining tokens at the end of the match. If the number remaining is:

1: **10**, 2: **15**, 3: **25**, 4: **35**, 5: **50**, 6: **50**

*(See Rules, Outside Home 1 and 2)*



# Rules

## IMPORTANT!

All Robot Game wording means precisely and only what it says. If a detail is not mentioned, it does not matter.

If a situation arises that makes the referee's decision unclear or hard to call, you get the benefit of the doubt. Text always has authority over pictures. (Videos and emails have no authority when scoring.)

If rules, missions, or the field setup needs adjustment or clarification, a Challenge Update will be issued during the season, superseding previous materials. At an event, your head referee makes the final decision.

Challenge  
Updates



## Glossary

- **Equipment:** Everything teams bring to the match. (See [“Equipment”](#) section for more details.)
- **Field:** This consists of the border walls and everything inside them. The mat, the mission models, and the home areas are all part of the field.
- **Interruption:** When technicians interact with the robot or anything touching it after launch.
- **Launch:** When technicians activate the robot from completely within a launch area to move autonomously.
- **Match:** The 2.5 minutes when the robot completes as many missions as possible to earn points.
- **Mission:** One or more tasks that can be completed for points. Teams may try missions in any order or combination.
- **Precision Tokens:** The six red LEGO discs included in the annual Challenge set. They are worth free points, but in some situations, a referee may remove them one at a time. (See [“Outside Home”](#) section for more details.)
- **Robot:** Your controller and any equipment combined with it by hand and intended to not separate from it, unless by hand.
- **Technicians:** Team members standing at the table who are handling the robot during a match.

## New This Year

- There are now two home areas and two areas to launch from.
- Four technicians, two on each side, are allowed at the field.
- The rules have been rewritten to account for all these changes, so please read through all materials carefully.

## BEFORE THE MATCH | EQUIPMENT

Equipment includes everything teams bring to the match, such as the robot, any attachments or accessories, and the team's Innovation Project model. This section explains what the robot and its accessories can be built from.

1. All equipment must be LEGO® made building pieces, in original factory condition.  
**Exception:** LEGO string and pneumatic tubes may be cut to length.

2. Non-electric LEGO pieces are allowed from any set. Teams may use as many as they like.

3. Electric LEGO equipment is allowed only as described and shown below. (The LEGO® Education SPIKE™ Prime is shown, but LEGO® Education SPIKE™ Essential, MINDSTORMS® EV3, MINDSTORMS Robot Inventor and equivalent NXT and RCX are also allowed).

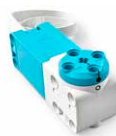
### Controller

Maximum of one in any one match.



### Motors

Maximum of four (any mix) in any one match.



### Sensors

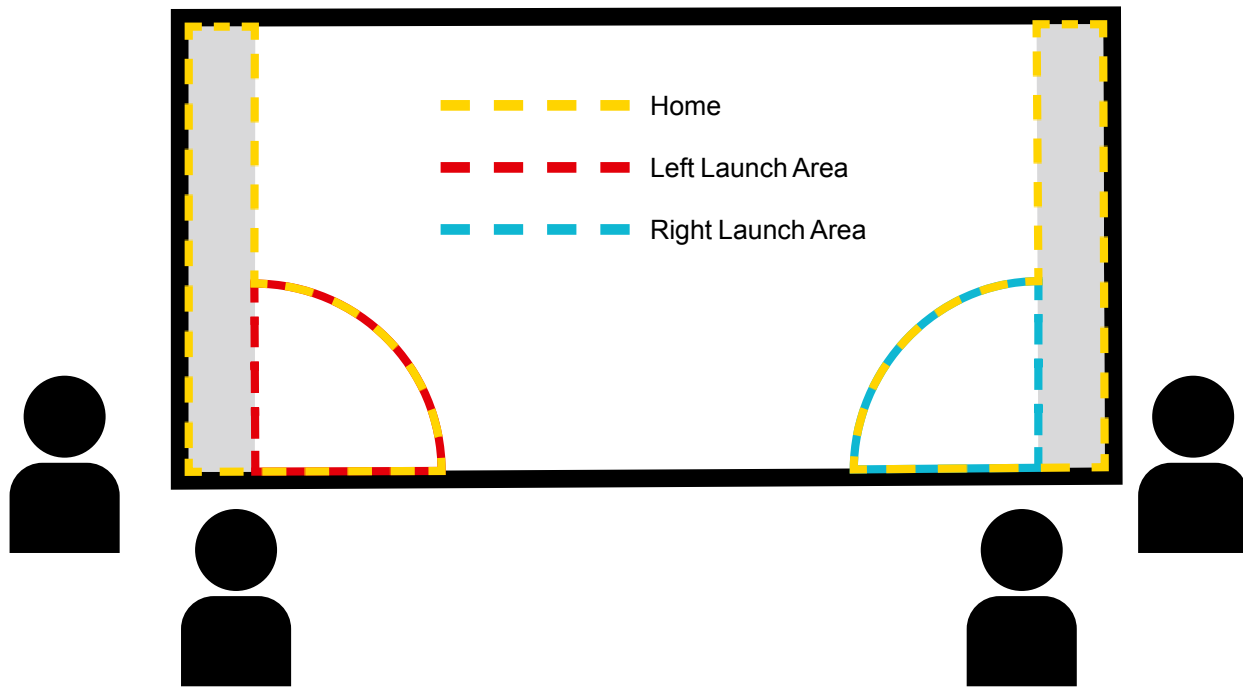
Only touch/force, color, distance/ultrasonic, and gyro sensors are allowed (any mix and number) in any one match.



4. Teams can also use LEGO wires, one controller's power pack or six AA batteries, and one microSD card.
5. Teams can use any software or programming language. Robots must be autonomous during the match. No remote controllers of any type are allowed.

6. Teams may bring one sheet of notebook paper per home area for program notes, and it does not count as equipment.
7. Additional or duplicate mission models are not allowed.





## BEFORE THE MATCH | MATCH SETUP

At events, matches are likely to be on official tables. Before the match begins, teams will need to pass the pre-match inspection and set all their equipment in place.

1. All the team's equipment must fit into the two launch areas and fit under a height limit of 12 in. (305 mm). However, if the team can fit all their equipment into just one launch area under a height limit of 12 in. (305 mm), they will earn 20 points.
2. Teams will not be given additional storage space. Storage tables or trolleys are not allowed. Everything must stay on the table or in the hands of a technician. The areas to the left and right of the mat can be used to store equipment and measure approximately 6.75 in. (171 mm) by 45 in. (1,143 mm) (actual measurements may vary). Equipment stored on the table may extend past the left and right walls as needed.

3. After the team has passed inspection, they will be given a couple of minutes to set up. They start by distributing their equipment and loose mission model(s) between the two home areas. (Some mission models must start in a specific home area. See ["Field Setup"](#) section for more details.) Next, they place their robot into the launch area they wish to start from. Any remaining time should be used to adjust the robot and equipment for the first launch, to calibrate sensors using any part of the mat, and to ask the referee to check anything on the field.
4. Team members must then divide into two groups and position one group at each side of the field (left and right). These members cannot switch sides during the match. If possible, position two technicians at each home area. All other team members must stand back. Teams may never have more than two technicians at a single home area, but team members may swap places with technician(s) on their side at any time.

## DURING THE MATCH | INSIDE HOME

Home is the team's safe space.

1. Home is split into two areas. Each home area contains its own launch area.
2. Technicians may use their hands on the robot, equipment, and mission models when these are completely within their home area.
3. When launching:
  - Technicians may not keep anything from moving.
  - The robot and anything it is about to move must fit completely inside the launch area.
4. Technicians may not touch anything outside of their home area or cause anything to move or extend outside this area, except the robot.
5. After any launch, technicians should allow the robot to return completely into home before interrupting it. (See [“Outside Home”](#) section for more details.)



## DURING THE MATCH | OUTSIDE HOME

1. If technicians interrupt their robot, it must be relaunched. If the robot was outside home (even partly) when it was interrupted, they lose one precision token.

Here is what happens to the robot when interrupted:

- **If the robot was partly outside home:** Bring the robot into that home area.
- **If the robot was completely outside home:** Return the robot to either home area.

Here is what happens to any equipment or mission models that were in contact with the robot when it was interrupted outside home (even partly):

- **If the object was with the robot when it launched:** Keep it. Bring it with the robot.
- **If the object was obtained after the robot was launched:** Give it to the referee for the remainder of the match.

**Exception:** If the team does not plan to launch again, they may stop their robot in place without losing a precision token. The robot and anything it is in contact with should remain in place where it was interrupted.

2. If a piece of equipment or a mission model is dropped or left outside of home, wait for it to come to rest:

- **If it rests completely outside home:** It stays as is unless the robot changes it.
- **If it rests partly in home:** It stays as is unless the robot changes it. Alternatively, at any time, the technicians may remove it by hand. If the object removed by hand was a mission model, it must be given to the referee for the remainder of the match. If the object was equipment, it must be taken into that home area, and the team will lose one precision token.

3. Teams cannot separate the Dual Lock, take models apart, or break a mission model. Teams also may not interrupt their robot in such a way that they earn points from it. Points scored in these ways will not count.

4. Teams may not interfere with the opposing field or robot unless there is a mission exception. Points failed or lost due to interference will score automatically for the other team.



## AFTER THE MATCH | SCORING

1. After 2.5 minutes, the match ends. Technicians must stop their robot and touch nothing else. This is when scoring begins.
2. For scoring, all mission requirements must be visible at the end of the match unless a method was required in the mission.
3. When something is required to be “completely in” an area, the lines and airspace above that area count as “in” unless otherwise mentioned.
4. If a team cannot run their robot, they can still gain *Gracious Professionalism*® points by explaining the situation or being present at the match.
5. The referee will document the results of the match with the team. When there is agreement on the results, it becomes official. If needed, the head referee makes the final decision. Only the team’s best score of the three matches counts toward awards and advancement. Ties are broken using second and third best scores.

FIRST LEGO LEAGUE CHALLENGE		Team #		Match:	Referee:	Table:	TEAM INITIALS:		SCORE
<b>EQUIPMENT INSPECTION</b> If your robot and all your equipment fit completely in one launch area and are under a height limit of 12 in. (305 mm) during the pre-match inspection.									20
<b>MISSION 01 INNOVATION PROJECT MODEL</b> If your Innovation Project model is at least partly in the hydrogen plant target area: <i>Design and bring a single Innovation Project model of your own to the match. To score, it must:</i> • Be made of at least two white LEGO® pieces. • Measure at least as long as four LEGO studs in some direction.									10
<b>MISSION 02 OIL PLATFORM</b> If a fuel unit is in the fuel truck: Bonus: If at least one fuel unit is in the fuel truck and the fuel truck is at least partly over the fueling station target.									5 EACH 10 ADDED
<b>MISSION 03 ENERGY STORAGE</b> If an energy unit is completely in the energy storage bin (max of three): If the energy unit is completely removed from the energy storage tray: <i>All energy units stored in the energy storage bin may not be touching team equipment at the end of the match.</i>									10 EACH 5
<b>MISSION 04 SOLAR FARM</b> If an energy unit has been completely removed from its starting circle: Bonus: If all three energy units have been completely removed from their starting circles.									5 EACH 5 ADDED
<b>MISSION 05 SMART GRID</b> If your field's orange connector is completely raised: Bonus: If both teams' orange connectors are completely raised: <i>The smart grid model may not be touching team equipment at the end of the match.</i>									20 10 ADDED
<b>MISSION 06 HYBRID CAR</b> If the hybrid car is no longer touching the ramp: If the hybrid unit is in the hybrid car:									10 10
<b>MISSION 07 WIND TURBINE</b> If an energy unit is no longer touching the wind turbine:									10 EACH
<b>MISSION 08 WATCH TELEVISION</b> If the television is completely raised: If an energy unit is completely in the green television slot: <i>The watch television model and the energy unit in the green television slot may not be touching team equipment at the end of the match.</i>									10 10
<b>MISSION 09 DINOSAUR TOY</b> If the dinosaur toy is completely in the left home area: If the dinosaur toy lid is completely closed: • And there is an energy unit inside: • Or there is a rechargeable battery inside:									10 10 20
<b>MISSION 10 POWER PLANT</b> If an energy unit is no longer touching the power plant: Bonus: If all three energy units are no longer touching the power plant:									5 EACH 10 ADDED
<b>MISSION 11 HYDROELECTRIC DAM</b> If the energy unit is no longer touching the hydroelectric dam:									20
<b>MISSION 12 WATER RESERVOIR</b> If a looped water unit is completely in the water reservoir, touching the mat: If a looped water unit is placed on a single red hook: <i>The loop on the looped water unit may extend out of the water reservoir.            Looped water units in the water reservoir or on red hooks may not be touching team equipment at the end of the match.</i>									5 EACH 10 EACH HOOK
<b>MISSION 13 POWER-TO-X</b> If an energy unit is completely in the hydrogen plant target area (max of three):									5 EACH
<b>MISSION 14 TOY FACTORY</b> If an energy unit is at least partly in the slot in the back of the toy factory (or in the red hopper) (max of three): If the mini dinosaur toy has been released: <i>Energy units stored in the toy factory may not be touching team equipment at the end of the match.</i>									5 EACH 10
<b>MISSION 15 RECHARGEABLE BATTERY</b> If an energy unit is completely in the rechargeable battery target area (max of three): <i>The rechargeable battery is not an energy unit.            Energy units stored in the rechargeable battery target area may not be touching team equipment at the end of the match.</i>									5 EACH
<b>PRECISION TOKENS</b> You begin the match with six precision tokens worth 50 free points. The referee holds onto them. If you interrupt the robot outside of home, the referee removes one token. You keep points for the number of remaining tokens at the end of the match. If the number remaining is: 1: 10, 2: 15, 3: 25, 4: 35, 5: 50, 6: 50									
<b>FINAL SCORE</b> Final score is equal to the sum of all values in the score columns.									
<b>Gracious Professionalism® displayed at the robot game table:</b>									
DEVELOPING		ACCOMPLISHED		EXCEEDS					
2		3		4					
SUPERPOWERED <sup>SM</sup> 31									

See pages 30-31 for scoresheet.

# Mission Models

To build the mission models, use the LEGO® pieces from your Challenge set and building instructions. The robot interacts with

mission models on the field for points. The mission models are built in Sessions 1-4 in the *Engineering Notebook*.

Now it's time to build! Have fun and be sure to build carefully!



**Caution:** It's important to build the models as accurately as possible because practicing with incorrect models could cause problems. Work as a team to build the models, and check each other as you build.



Model Building Instructions

# Mission Model Building Information

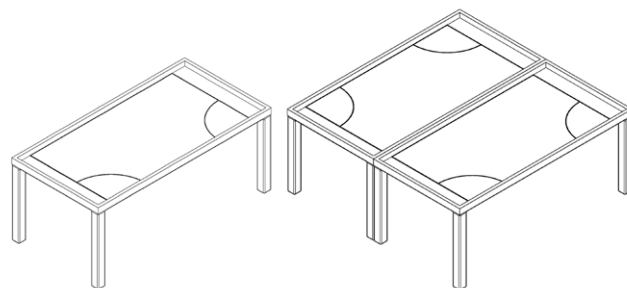
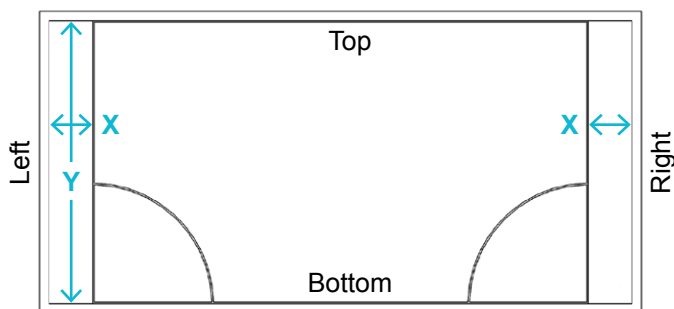
Bag Number	Bag Contents	Mission Number
<b>White Energy Journey</b>		<b>(Built in Session 1)</b>
7	Wind turbine model	07
4	Energy storage model	03
8	Watch television model	08
<b>Blue Energy Journey</b>		<b>(Built in Session 2)</b>
12	Water reservoir model and 3x looped water units	12
11	Hydroelectric dam model	11
13	Toy factory model	14
<b>Yellow Energy Journey</b>		<b>(Built in Session 3)</b>
2	Oil platform model	02
3	Fuel truck model	02
6	Hybrid car and ramp model	06
<b>Orange Energy Journey</b>		<b>(Built in Session 4)</b>
10	Power plant model	10
5	Smart grid model	05
9	Dinosaur toy model	09
<b>Miscellaneous</b>		
1	12x energy units, 3x fuel units, 1x water unit, 1x hybrid unit, 1x rechargeable battery	Multiple missions
14	Innovation Project bricks	01
15	Design tiles for display wall	03
16	Precision tokens	N/A
16	Coach pins and season tiles	N/A



# Field Setup

## Field Mat Placement

1. Check the table surface for bumps. Sand or file them away and then vacuum well.
2. On the vacuumed table only, unroll and place the mat as shown below. Never fold the mat, and never crush or bend a rolled mat.
3. Slide the mat against the bottom border wall and align it centrally. There should be no gaps except for one at the top wall of about 1/4 in. (6 mm). When table size and mat placement are correct, the areas to the left and right of the mat each measure about  $X = 6.75$  in. by  $Y = 45$  in. (171 mm by 1,143 mm).
4. Optional – To hold the mat in place, you can use thin strips of black tape, covering only the mat's left and right borders.

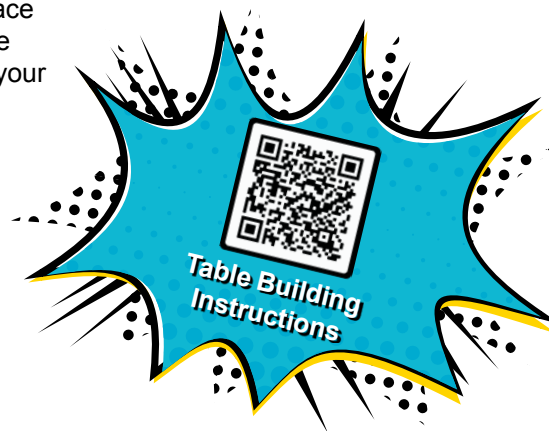


Practice setup

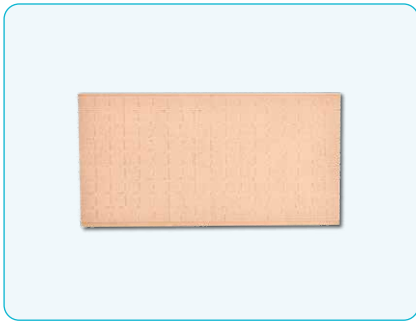
Tournament setup

**NOTE:** If you compete, remember that volunteers work hard to get the fields just right, but you should expect and design for rare imperfections such as bumps under the mat or changes in light.

Practicing without an official table or border walls is okay, but competitions will be held on an official table in tournament setup. Please practice with this in mind and remember to mark out the space needed for home on each side of your mat.

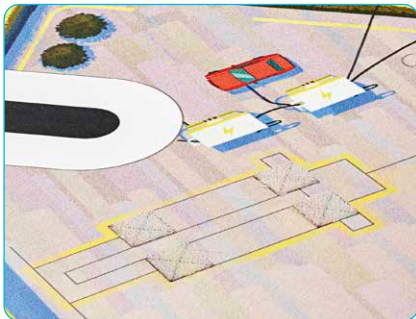


## 3M™ DUAL LOCK™ RECLOSABLE FASTENER PLACEMENT

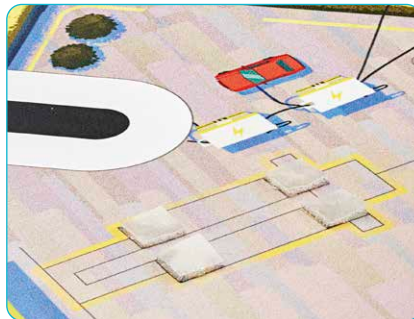


You will find sheets of Dual Lock™ squares in your Challenge set to secure the models to the mat. Dual Lock is an important part of field setup. If the models are not secured properly, you will have difficulty completing the missions.

**SECURING MODELS** – The squares on the mat with the X inside show where to apply the Dual Lock. Use the Dual Lock as shown in this example and be very exact. When pressing down a model, press on its base instead of pressing from higher up, which might crush the model. To remove the model from the mat, lift it from its base to separate the Dual Lock.



**Step 1:** First Dual Lock square sticky side down.

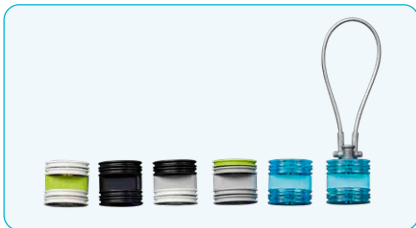


**Step 2:** Second Dual Lock square sticky side up.



**Step 3:** Align the model and press down.

## UNITS



Units from left to right:

- Energy (12x)
- Fuel (3x)
- Hybrid (1x)
- Rechargeable battery (1x)
- Water (1x)
- Looped water (3x)

See Missions

**02-04** and **06-15**

## INNOVATION PROJECT BRICKS



LEGO pieces found in Bag 14 used for prototyping your Innovation Project model.

See Mission

**01**

## DESIGN TILES



Tiles found in Bag 15 to be used on your team's design wall activity in Session 3 (optional) for the energy storage model.

See Mission

**03**

# Mission Model Setup

## HOME



In either area, place your Innovation Project model (if applicable).

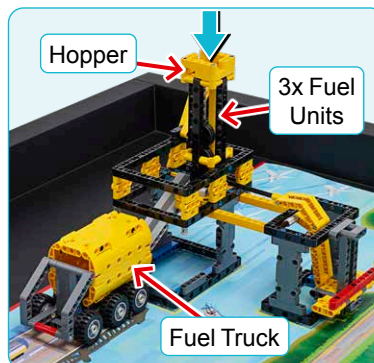


In the right home area, place the dinosaur toy.

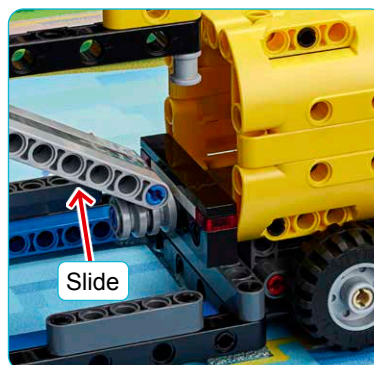
See Missions

**01** and **09**

## OIL PLATFORM



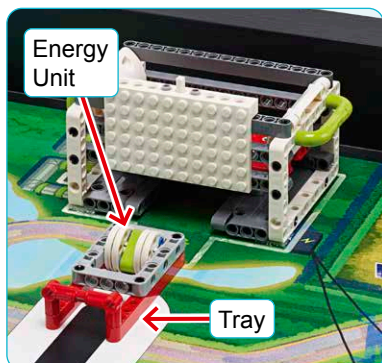
Lift the slide, push the fuel truck into place, and then lower the slide onto the fuel truck. Load three fuel units into the hopper.



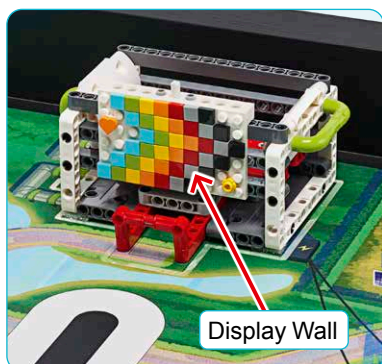
See Mission

**02**

## ENERGY STORAGE



Place an energy unit into the tray and push completely in as shown.

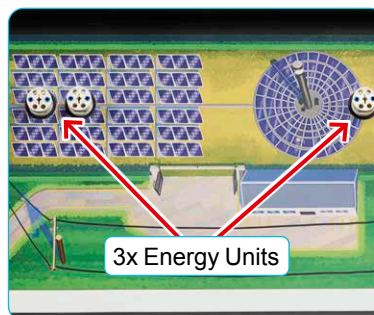


Teams may bring and use their display wall in the robot game at an event. Alternatively the blank white display wall will be provided.

See Mission

**03**

## SOLAR FARM

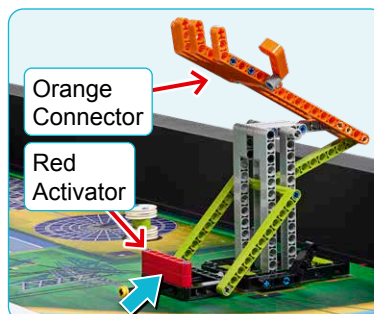


Place three energy units as shown.

See Mission

**04**

## SMART GRID



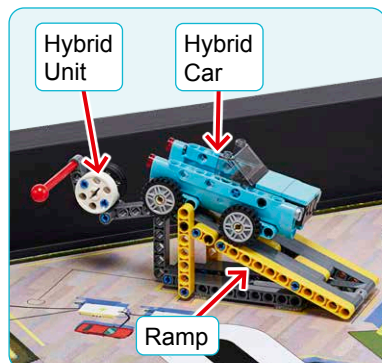
Push the red activator completely in.

See Mission

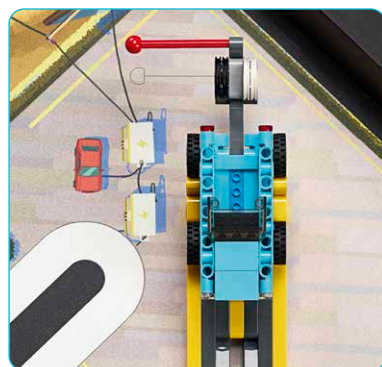
**05**



## HYBRID CAR



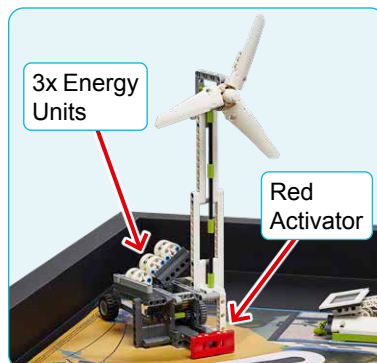
Place the hybrid unit and hybrid car as shown so that car's rear wheels rest just behind the ramp.



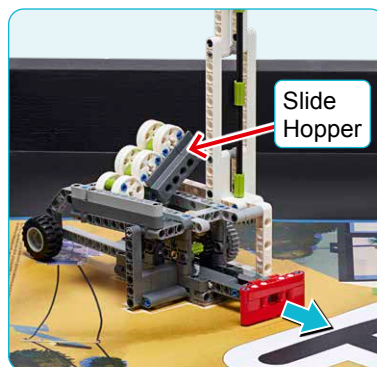
See Mission

06

## WIND TURBINE



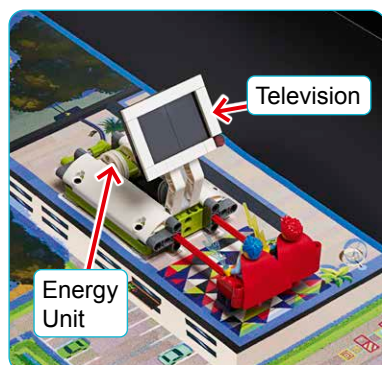
Pull the red activator completely out. Load three energy units onto the slide hopper as shown.



See Mission

07

## WATCH TELEVISION



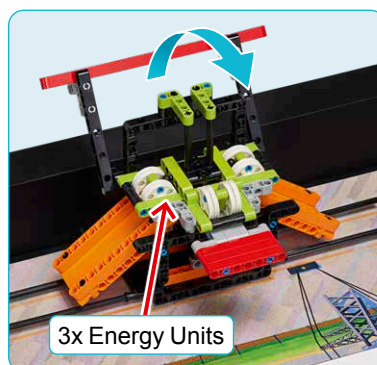
Place an energy unit beneath the television. Lower the television and pull the red sofa completely out.



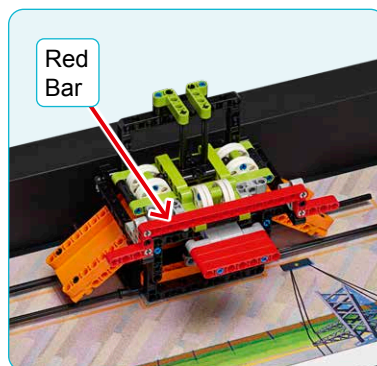
See Mission

08

## POWER PLANT



Load three energy units and lower the red bar as shown.

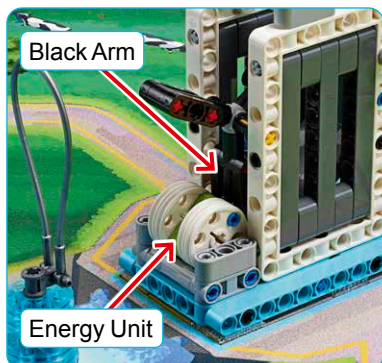


See Mission

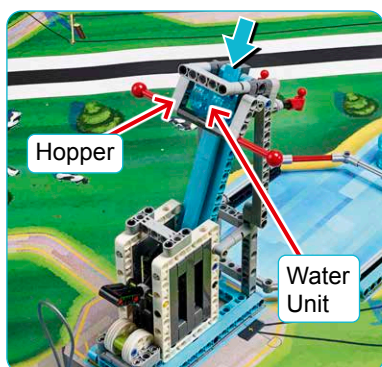
10

# Mission Model Setup

## HYDROELECTRIC DAM



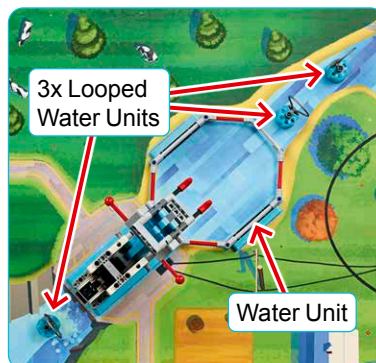
Place an energy unit in front of the largest black arm on the turbine wheel at the bottom of the model. Load a water unit into the hopper.



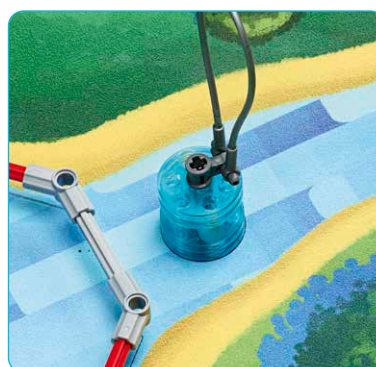
See Mission

11

## WATER RESERVOIR



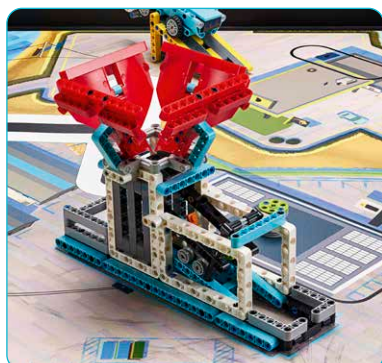
Place the water reservoir frame and three looped water units as shown (loops on the looped water units should align with lines on the mat).



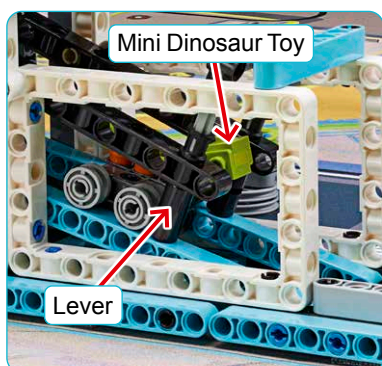
See Mission

12

## TOY FACTORY



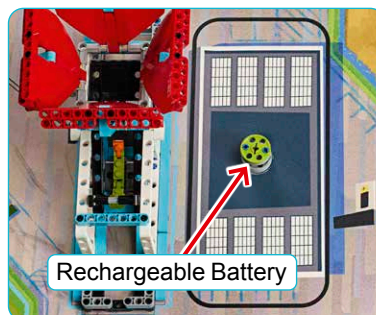
Lift the black lever up and push the mini dinosaur toy so that it rests behind the black lever.



See Mission

14

## RECHARGEABLE BATTERY



Place the rechargeable battery as shown.

See Mission

15

## PRECISION TOKENS



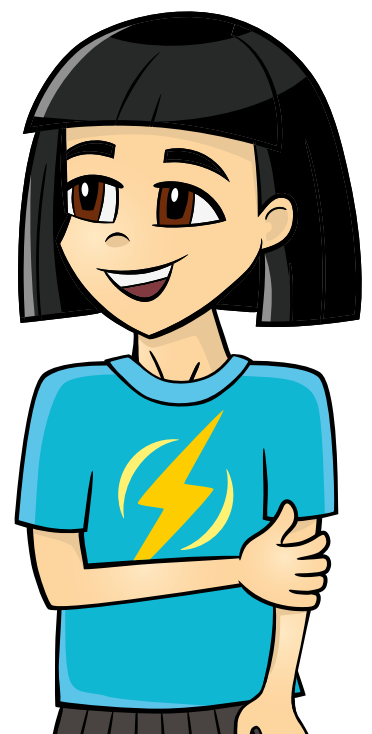
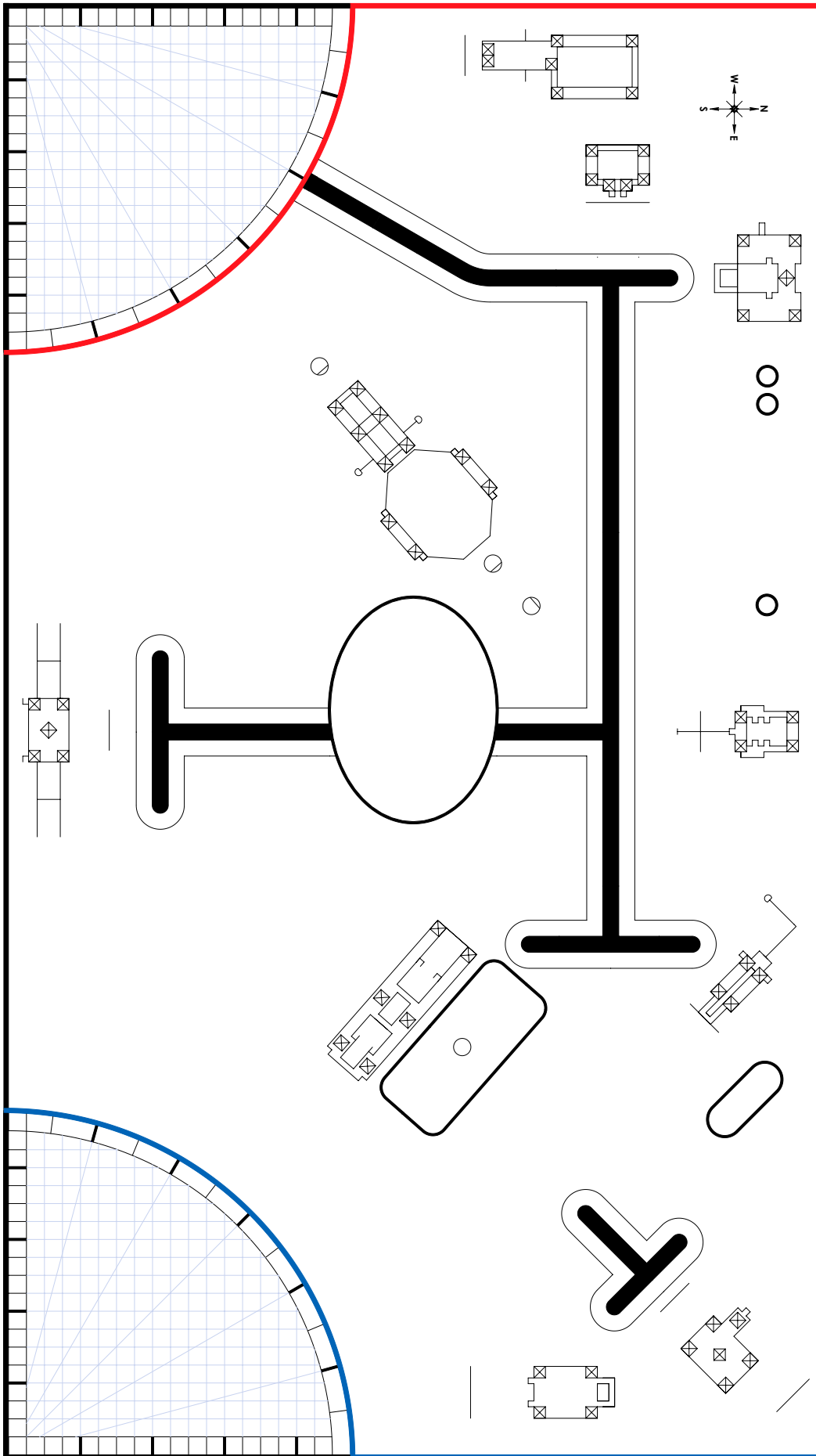
Give to the referee to hold for the duration of the match.

# Robot Path Diagram

Draw the route your robot will take to solve the mission(s).

You could use colors to indicate each run the robot will make and which launch area it will return to.

Decide which side your equipment will start at.





Team #	Match:	Referee:	Table:
TEAM INITIALS:			

			SCORE
<b>EQUIPMENT INSPECTION</b>			
If your robot and all your equipment fit completely in one launch area and are under a height limit of 12 in. (305 mm) during the pre-match inspection:			20
<b>MISSION 01 INNOVATION PROJECT MODEL</b>			
If your Innovation Project model is at least partly in the hydrogen plant target area:			10
<i>Design and bring a single Innovation Project model of your own to the match. To score, it must:</i>			
• Be made of at least two white LEGO® pieces.			
• Measure at least as long as four LEGO studs in some direction.			
<b>MISSION 02 OIL PLATFORM</b>			
If a fuel unit is in the fuel truck:			5 EACH
Bonus: If at least one fuel unit is in the fuel truck and the fuel truck is at least partly over the fueling station target:			10 ADDED
<b>MISSION 03 ENERGY STORAGE</b>			
If an energy unit is completely in the energy storage bin (max of three):			10 EACH
If the energy unit is completely removed from the energy storage tray:			5
<i>All energy units stored in the energy storage bin may not be touching team equipment at the end of the match.</i>			
<b>MISSION 04 SOLAR FARM</b>			
If an energy unit has been completely removed from its starting circle:			5 EACH
Bonus: If all three energy units have been completely removed from their starting circles:			5 ADDED
<b>MISSION 05 SMART GRID</b>			
If your field's orange connector is completely raised:			20
Bonus: If both teams' orange connectors are completely raised:			10 ADDED
<i>The smart grid model may not be touching team equipment at the end of the match.</i>			
<b>MISSION 06 HYBRID CAR</b>			
If the hybrid car is no longer touching the ramp:			10
If the hybrid unit is in the hybrid car:			10
<b>MISSION 07 WIND TURBINE</b>			
If an energy unit is no longer touching the wind turbine:			10 EACH
<b>MISSION 08 WATCH TELEVISION</b>			
If the television is completely raised:			10
If an energy unit is completely in the green television slot:			10
<i>The watch television model and the energy unit in the green television slot may not be touching team equipment at the end of the match.</i>			

<b>MISSION 09 DINOSAUR TOY</b>		
If the dinosaur toy is completely in the left home area:	10	
If the dinosaur toy lid is completely closed:		
• And there is an energy unit inside:	10	
• Or there is a rechargeable battery inside:	20	
<b>MISSION 10 POWER PLANT</b>		
If an energy unit is no longer touching the power plant:	5 EACH	
Bonus: If all three energy units are no longer touching the power plant:	10 ADDED	
<b>MISSION 11 HYDROELECTRIC DAM</b>		
If the energy unit is no longer touching the hydroelectric dam:	20	
<b>MISSION 12 WATER RESERVOIR</b>		
If a looped water unit is completely in the water reservoir, touching the mat:	5 EACH	
If a looped water unit is placed on a single red hook:	10 EACH HOOK	
<i>The loop on the looped water unit may extend out of the water reservoir. Looped water units in the water reservoir or on red hooks may not be touching team equipment at the end of the match.</i>		
<b>MISSION 13 POWER-TO-X</b>		
If an energy unit is completely in the hydrogen plant target area (max of three):	5 EACH	
<b>MISSION 14 TOY FACTORY</b>		
If an energy unit is at least partly in the slot in the back of the toy factory (or in the red hopper) (max of three):	5 EACH	
If the mini dinosaur toy has been released:	10	
<i>Energy units stored in the toy factory may not be touching team equipment at the end of the match.</i>		
<b>MISSION 15 RECHARGEABLE BATTERY</b>		
If an energy unit is completely in the rechargeable battery target area (max of three):	5 EACH	
<i>The rechargeable battery is not an energy unit. Energy units stored in the rechargeable battery target area may not be touching team equipment at the end of the match.</i>		
<b>PRECISION TOKENS</b>		
You begin the match with six precision tokens worth 50 free points. The referee holds onto them. If you interrupt the robot outside of home, the referee removes one token. You keep points for the number of remaining tokens at the end of the match. If the number remaining is:		
1: 10, 2: 15, 3: 25, 4: 35, 5: 50, 6: 50		
<b>FINAL SCORE</b>		
Final score is equal to the sum of all values in the score columns.		
<b>Gracious Professionalism® displayed at the robot game table:</b>		
<b>DEVELOPING</b>	<b>ACCOMPLISHED</b>	<b>EXCEEDS</b>
2	3	4

