



## **SITUATION :**

Canada has its Formula 1 event and recently its Formula E (Electric) event. Many young Canadians participate actively in these competitions, some as drivers but mostly as young engineers.

Racing teams need your creativity to increase the speed of the cars, their reliability and safety with new technologies, new materials and new ideas.

To prepare you, here comes the Formula 01. You now have your own LEGO race team and you have to get ready to compete against other cars on a big circuit.



## OVERALL ROBOT FUNCTION:

You must prepare a racing car capable of performing laps **autonomously** without colliding with other cars. In addition, you must respect certain technical and sporting constraints.

- *New*: In this challenge, you will need to use directional front wheels. So you cannot just change the speed of the rear wheels to run your car.
- The schedule for the day includes practice sessions, qualifications and the autonomous race.
- A second remote controlled race will take place to please the drivers. This race will include a mandatory pit stop for all teams to change the tires and the driver. This will require your team to train to make this change quickly.

### EXAMPLE OF MODEL F01

Zone01 makes plans available for a basic robotized F01. The plan makes it possible to build an F01 using an EV3 Education core set, with the exception of the rear wheels that come from an EV3 expansion kit and from the second colour sensor which will be very useful in order to increase the car's speed.



You can use this model, modify it or build your own F01 while respecting the below specifications.



*Did you know? The biggest tire manufacturer in the world is not Goodyear, Pirelli, Michelin or Bridgestone, but LEGO!*

## DESCRIPTION OF THE ROBOT (TECHNICAL REGULATION):

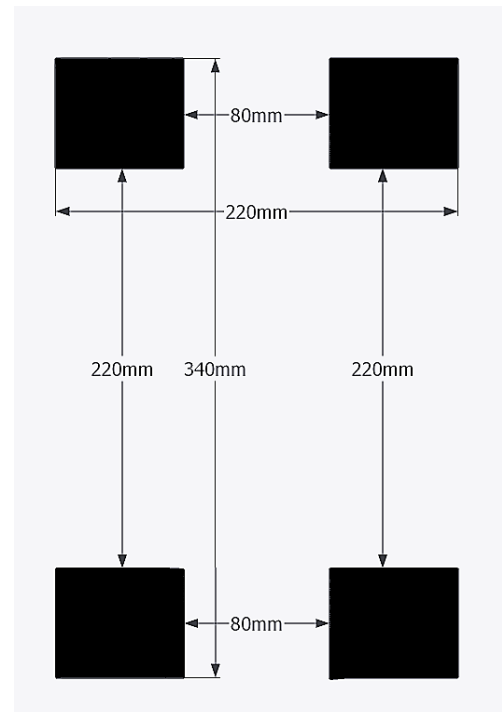
**All the following constraints must be respected. An inspection will be carried out on each car before qualifying and before departure.**

### Dimensions:

The following dimensions must be respected:

Maximum length: 40 cm  
Maximum width: 22 cm  
Maximum height: 15 cm

Wheel location: The front and rear wheels of your car must **touch the ground** into the black squares of the diagram **to the right**.



### Motors:.

Two large EV3 motors are used to propel the car, one motor per rear wheel. **They operate independently.**

A medium motor is used for steering by rotating the two front wheels.

An optional 4th motor (large or medium) can only be used to drive one or more sensors on the car, if desired.

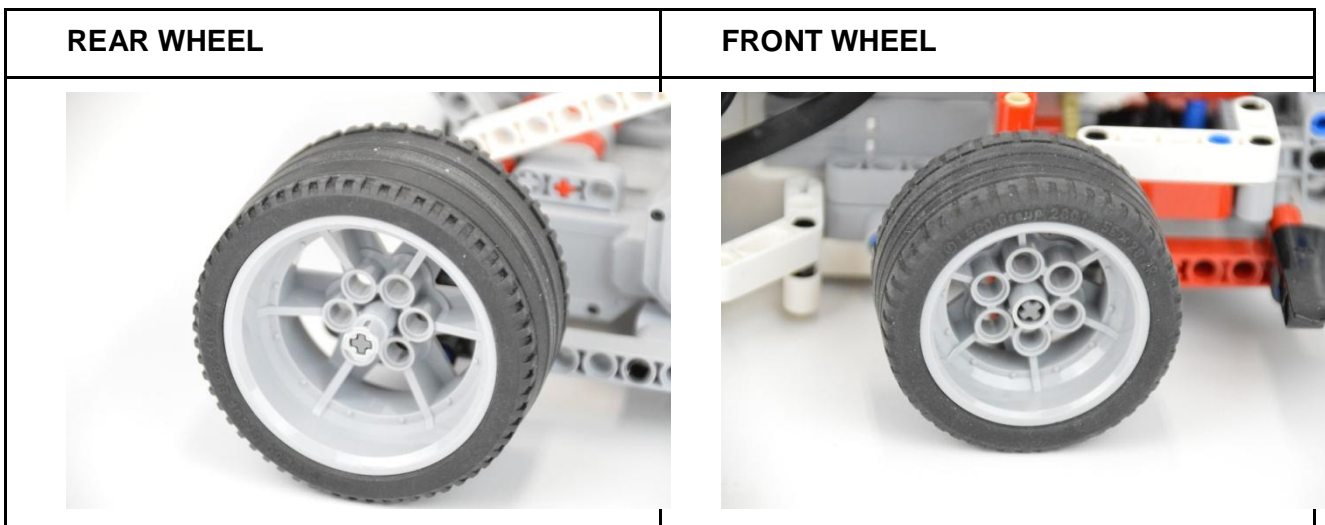


### Energy source:

Only one EV3 rechargeable battery or 6 AA batteries can be used to power the car's EV3 brick. Only one EV3 brick is allowed.

### Wheels and tires:

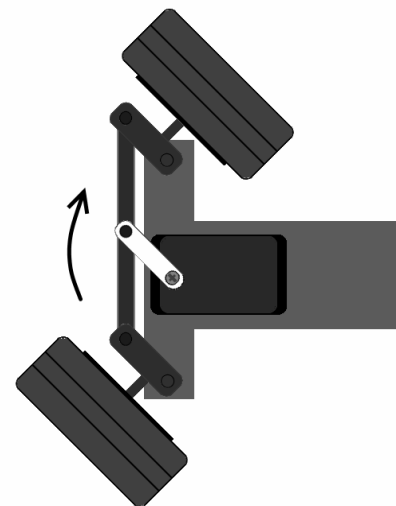
The wheels and front tires of the car are part of the LEGO EV3 Education kit (wheel #4634091, tire #6035364). The rear wheels are available in the LEGO EV3 extension kit (#4211845 and #4614801). All wheels are gray.



### Steering:

Unlike vehicles usually manufactured with the EV3 Education package, your F01 must use directional front wheels. The wheels turn at the same time to the left or to the right using a medium motor. Since the front wheels touch the ground at all times, it is not possible to make a turn by simply varying the speed of one of the rear drive wheels.

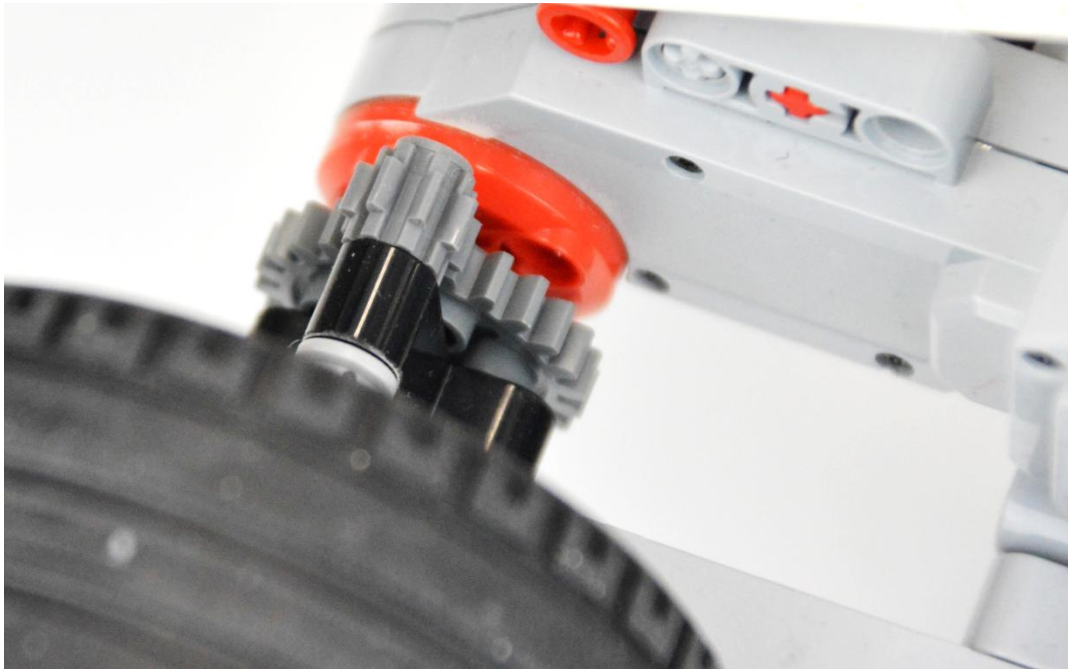
The figure opposite shows an example of valid steering.





## Gearbox:

The F01 model proposed by Zone01 uses gear wheels with 24 teeth and 8 teeth for the rear wheels (ratio of 3:1). You are allowed to modify this ratio by using different gear wheels. It's up to you to experiment. Automatic gearboxes are not permitted.



## Sensors:

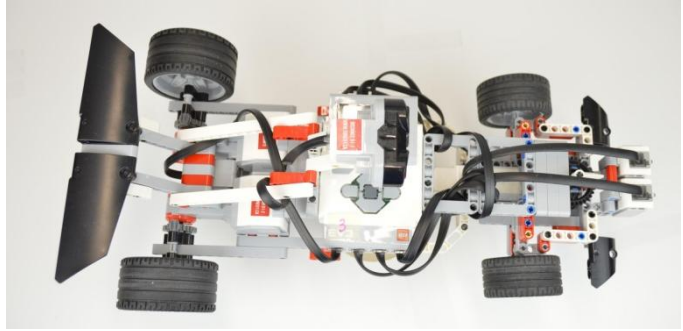
You can use only the sensor models available in the basic EV3 education kit (tactile, ultrasonic, gyroscopic and colour). However, a team may decide to make swaps from one kit to another, for example by replacing a touch sensor with a second ultrasonic sensor. **However, a car cannot use more than two sensors of the same type.**

## Cables:

The cables must be secured on the car to prevent them from coming into contact with other cars.



Other cars should not be able to get caught in your vehicle's cables. A car deemed dangerous will not be allowed on the circuit.

| SECURED CABLES  | UNSECURED CABLES |
|---|------------------|
|  |                  |

### Installation of the transponder:

Robotics Zone01 will lend each team a transponder that will have to be installed on the car. This will be used to calculate the times and count the number of completed laps.

## INSPECTION

On the day of the race, the cars will be inspected to ensure that they comply with technical regulations. The car must be placed on a printed sheet that indicates the permitted location of the tires. The tires should touch only the black areas of the sheet. No other parts can touch the ground.

The car must then be able to pass through a frame for the length and width to validate that it respects the permitted length, width and height.

## RACE PLAN (SPORT REGULATIONS)

### Free practice:

On the day of the competition two free practice sessions of 45 minutes will allow the teams to determine the right settings for the track and improve times.



## Qualifications:

A qualifying period will be allocated to each team. This time will allow each car to perform laps of the circuit. Each completed lap will be timed and your best lap will be displayed on the main screen. Finally, the best times of each team will be compared and will determine the ranking of the cars on the starting line.

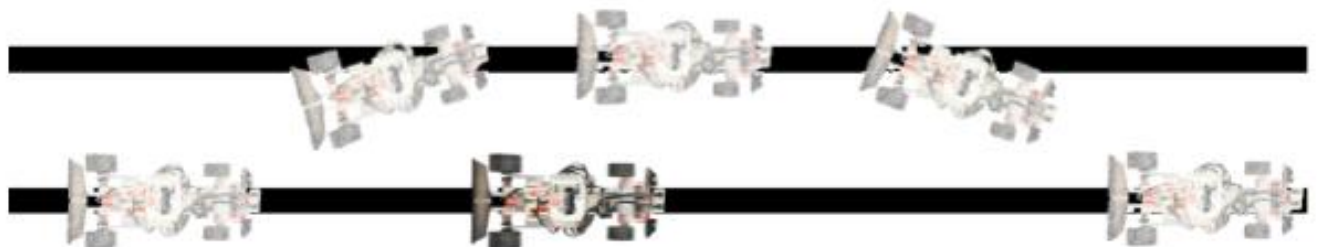
## Start of the autonomous race:

This is a race with a standing start. This means that at the start signal, drivers will start the car by pressing the centre button of the brick. If a car starts before the start signal, or takes an unreasonable amount of time to start, it will be considered a false start. In the event of a false start, the faulty car will be relegated to the bottom of the grid, behind all the other cars, and the start will be resumed. A car making two false starts will be disqualified.



## Passing:

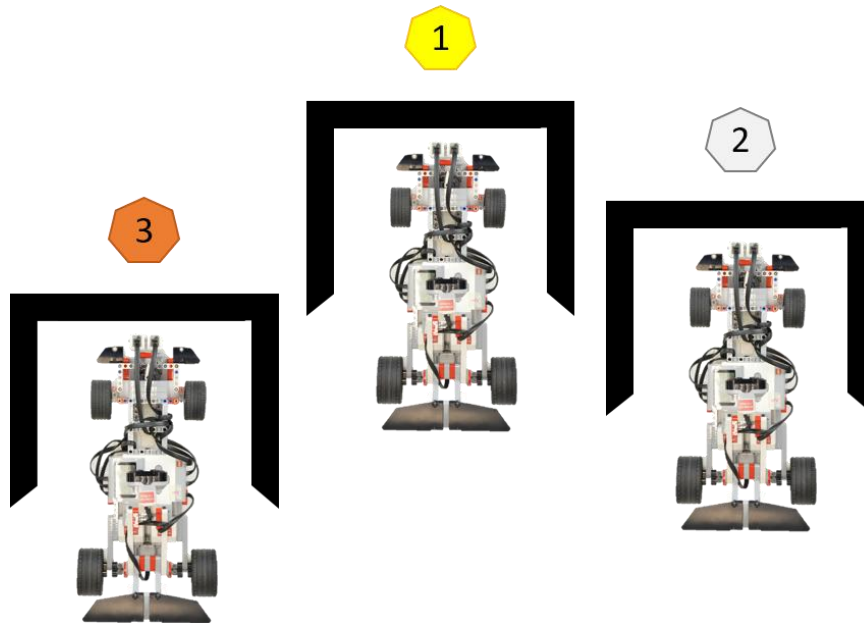
Passing an opponent is allowed on condition of doing so without causing a collision. On the long straight line(s), a passing lane will be available. A piece of reflective metal tape placed to the left or to the right of the course line will indicate the presence of a passing lane. A car may decide to use the passing lane if another car is in front of it. A car that is passing is responsible for returning to the normal racing lane safely without causing a collision. A car that is overtaken cannot make a manoeuvre to block an opponent.



## End of the autonomous race:

The race ends when a first car completes the expected number of laps. The number of laps to be completed will be announced on the day of the race and will depend on the configuration of the circuit.

The other cars will finish their race when they cross the finish line, regardless of the number of laps completed. They will have a maximum of 1 minute to complete their lap after the winner passes the



finish line.

## Remote controlled race:

The remote controlled race is also be a race with a standing start. Positions on the grid will remain as in the autonomous race. The driver can use a phone, an EV3 brick or a [Mindsensors PSP-NX](#) communication module with the Mindsensor or a PlayStation remote control.







## Pit stop :

During the remote controlled race, each team must plan a **tire (and wheel) change** in the pit lane. The car will have to be driven to the pit lane to allow the team to make the change quickly before returning to the race.

Zone01 will provide each team with a set of spare wheels and tires for the race. The wheels supplied will be black. All cars must start with gray wheels but must finish the race with black wheels.

A car returning to the track after passing through the pit must re-enter the track safely without causing a collision. The pit stop will also include a **driver change**. The new driver will keep the remote control until the end of the race.

## CIRCUITS AND TRACKS

### Circuits:

At each event, the configuration of the circuit could be different from that of the previous race. Each circuit will be a succession of turns and straight lines. The distance to be covered per lap will vary according to the circuit and the space available to accommodate it.

The big straight line will have its own orientation. That means that if the straight line is in the 0° direction, no other portion of the circuit will be oriented in the -15° to 15° range.

The minimum radius of any turn will be 45 cm.

### Course line:

A 4 cm-wide black line will be placed in the centre of the track throughout the circuit. It can be used by cars as a course line.

On the long straight line(s), the course line will be doubled to allow passing. The passing lane will be placed about 30-40 cm from the main lane.



## Timing bridge:

A bridge will be built at the start-finish line to detect the transponders with which the cars will be fitted. For each car, the stopwatch starts when the bridge is crossed. The times will be used to determine the order of cars during qualifying and to determine the holder of the fastest lap.

## CIRCUIT EXAMPLE TO COME

## DETAILED DESCRIPTION OF THE CHALLENGE

| <b>Time allowed</b>  |
|--|
| <p><b>Qualifications:</b><br/>Each team will have 5 minutes to complete qualification laps.</p> <p><b>Race:</b><br/>Once the first car completes the expected number of laps, each remaining car will have 1 minute to complete its current lap.</p> |
| <b>Difficulty level</b>  |
| <p>Programming: +++<br/>Design :+<br/>Strategy:+++</p>   |
| <b>Recommended sensors</b>   |
| <p><b>Reminder: A maximum of two sensors of each type can be used</b></p> <ul style="list-style-type: none"><li>a. Colour sensor</li><li>b. Ultrasonic sensor</li><li>c. Gyroscopic sensor</li><li>d. Touch sensor</li></ul>                         |



### The official race step by step

1. The team presents itself with its car at the inspection table. The team will then be invited to place its car on the track in the order established following the qualifications.
2. At the signal, all cars are switched on.
3. During the race, at the time of your choosing, your car must return to the pits to allow the team to change tires and wheels.
4. Once a first car crosses the finish line, all of its laps being completed, the other cars have 1 minute to complete their laps. The final ranking will be displayed on the giant screen.

## POINT CHART

Points will be awarded according to the position at the finish according to the FIA grid

|      |           |
|------|-----------|
| 1st  | 25 points |
| 2nd  | 18 points |
| 3rd  | 15 points |
| 4th  | 12 points |
| 5th  | 10 points |
| 6th  | 8 points  |
| 7th  | 6 points  |
| 8th  | 4 points  |
| 9th  | 2 points  |
| 10th | 1 point   |

Special mentions will be awarded for:

- Fastest lap in the race
- Pole position in qualification



## PENALTIES

|   |                      |
|---|----------------------|
| The car leaves the track and the intervention of a race steward is necessary                  | +30<br>seconds       |
| The car loses a part on the track or on the pit line  | +30<br>seconds       |
| The car finishes its race without having stopped at the pits and changed the wheels and tires | Disqualific<br>ation |
| The car causes a collision  | +30 seconds          |

## STRATEGY SUGGESTIONS

### STEPS TO BE FOLLOWED DURING YOUR PRACTICES

1. The car is able to follow the line at low speed and perform laps
2. The car is able to follow the line at high speed along the straight lines and slow down in the curves
3. The car is able to detect the car in front of it and avoid a collision
4. The car is able to determine if it can exceed the car ahead of it, and is able to perform the manoeuvre in a safe manner

## TUTORIALS TO COME

A host of tutorials will be created for this challenge, including:

- How to follow a line with directional wheels
- How to program differential software for the rear wheels
- How to accelerate along straight lines and slow down on curves
- How to detect the presence of a passing lane



## Frequently Asked Questions

As the season progresses, questions and clarifications are made to the challenge. Do not forget to check out the FAQ below