

**RobotShop**

Inc.

[www.robotshop.com](http://www.robotshop.com)

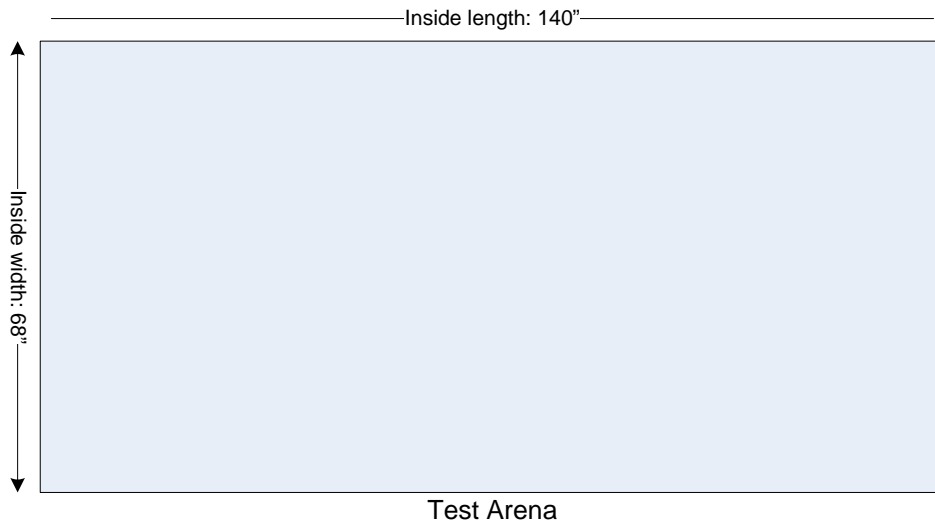
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La robotique à votre service!™ - Robotics at your service!™



## Ultimate Robot Vacuum Challenge Scoring Criteria

Below you will find an overview of the different challenges the Robot Vacuums will compete in\*\*. The test arena these challenges will be performed in is a rectangular enclosure with inner dimensions of approximately 140" x 68":



### 1. Time to Clean a Room Challenge

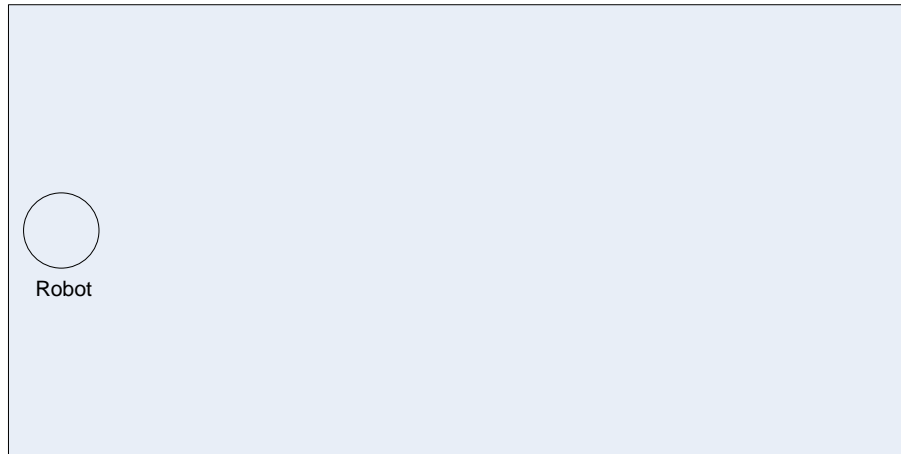


The robotic vacuum will need to clean a rectangular sized room as fast as it can. All robots will be started from the same place and be filmed during their cleaning cycle. We will record the time it takes for the robot to completely cover the surface of this cleaning environment.

We will time how long it takes the robot to completely clean a room and use the following points table in order to calculate the points:

Time (Min)	Points
0>=1	50
1>=5	30
5>=10	20
10>=20	10
20>=30	5
>30	0

## 2. Vacuuming Debris Challenge



Challenge 2

The robotic vacuums will need to complete a series of short challenges by picking up fine and large debris. They will need to pick up the following debris:

- Pieces of paper (20g)
- Assorted hardware (nuts & screws) (140 pieces)
- Hair + dirt (20g)

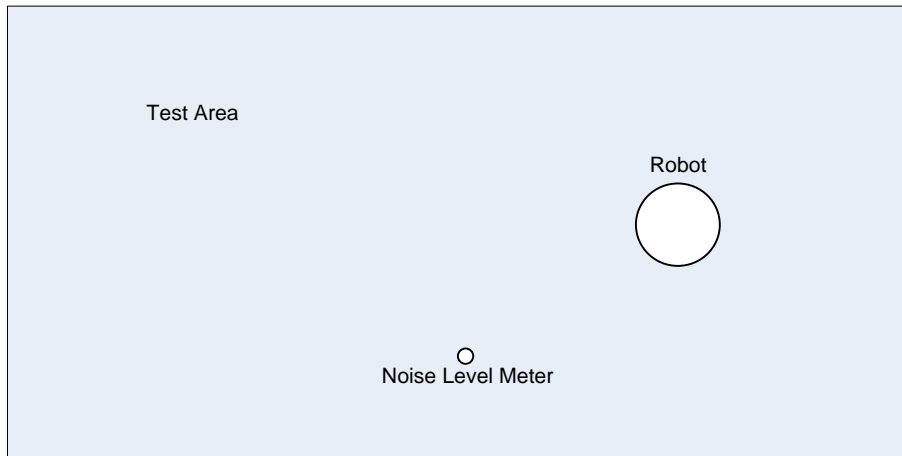
All robot vacuums will be required to pick up the same amount of debris and clean during the same amount of time. Cleaning time will be 5 minutes per cycle (per debris) for hard floors and 10 minutes for carpet. Tests will be done on carpet and hard floors. The collected debris will then be weighed with a precision balance to see how much the robot picked up; the debris picked up will be compared to the debris put in the arena. Points will be given depending on the percentage of the total debris each robot picked up.

Points will be calculated as follows on hard floors and carpet:

Weight(%)	Points
100<=90	40

90<=80	30
80<=70	20
70<=60	10
60<=0	0

### 3. Noise Level Challenge



Challenge 3 – Noise Level

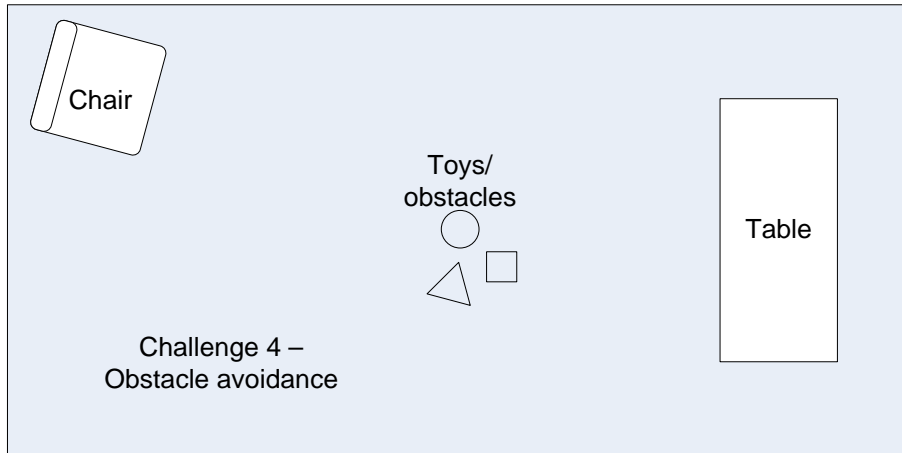
For this test a decibel reader will be used to measure the robots' noise level while they are vacuuming. Customers usually prefer robots that are quiet and therefore, the robot that gets the lowest reading will get the first place and the most points.

The robots will be run for two minutes each on both carpet and hard floor. We will calculate the max reading for each robot. We will then be able to score the robot on carpet, and on hard floor.

Points will be calculated as follows:

Decibel	Points
40>=50	25
50>=60	15
60>=70	5
70>=80	0
80>=90	-5
90>=100	-15
>100	-25

#### 4. Ability to “see” obstacles Challenge



Different robot vacuums have different ways of “seeing” or sensing obstacles, some bump into obstacles some soft touch and some don’t touch at all. This test will be taken by having each robot clean in the test area for 2 minutes while we count the hard bumps, soft touches and no touches. Following is the points table depending on the way the robot will touch the walls of the test area:

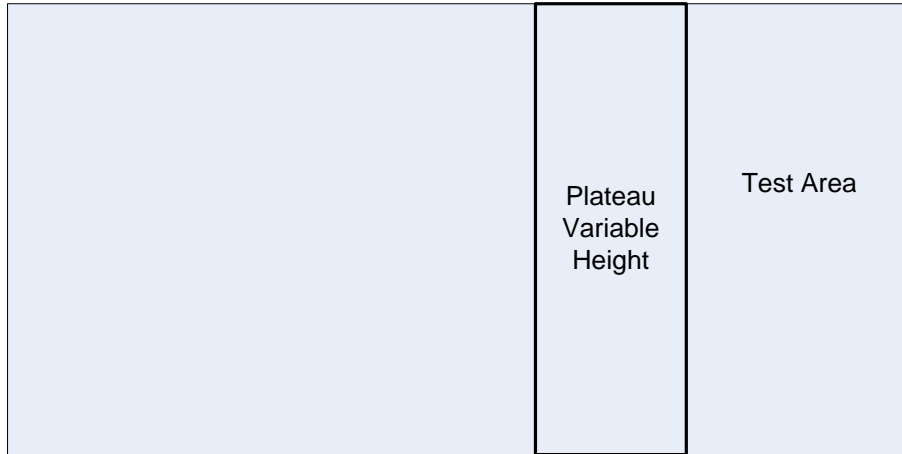
Touches	Points
No Touch	10
Soft Touch	2
Hard Bump	-1

Part of seeing an obstacle involves avoiding it, or at least not getting stuck on it. The robot will be tested if it can avoid getting entangled in low hanging curtains or electrical wires, as described by the following tables:

Curtains	Points
Gets Stuck	-5
Doesn't Get Stuck	10
Gets Stuck and Frees Itself	5

Electrical Wires	Points
Gets Stuck	-5
Doesn't Get Stuck	10
Gets Stuck and Frees Itself	5

## 5. Ability to Climb Obstacles Challenge



Challenge 5: Ability to Climb Obstacles

This challenge will test the ability of different robot vacuums to climb different obstacles with different heights. Some customers might have room separators or floors that are of different heights. This challenge will be performed with three different heights. 0.5cm, 1cm and 2cm. We will be testing if the robot climbs, does not climb, or gets stuck. Following is the points table that will be used for all three heights:

### 0.5cm cliff

Climb Options	Points
Climbs	5
No Climb	0
Gets Stuck	-5

### 1.0cm cliff

Climb Options	Points
Climbs	10
No Climb	0
Gets Stuck	-5

### 2.0cm cliff

Climb Options	Points
Climbs	20
No Climb	0
Gets Stuck	-5

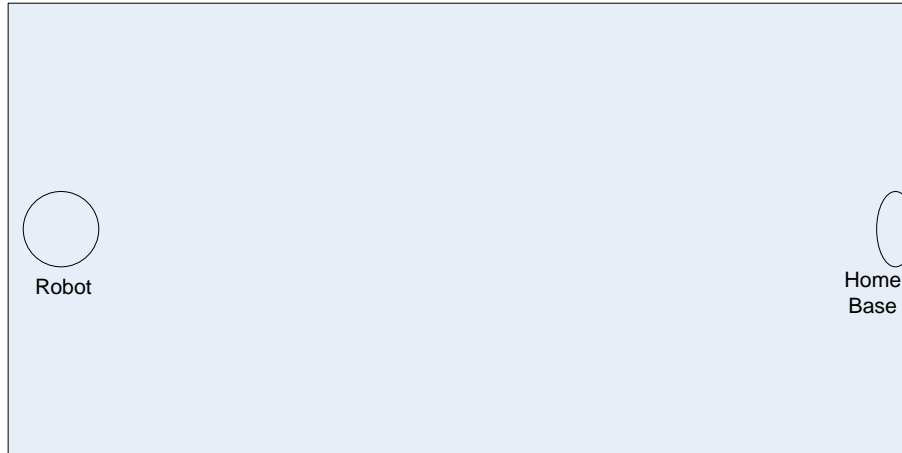
## 6. Cliff Sensor Challenge

This challenge will test the robot vacuum's ability to avoid cliffs and falling down drop-offs. All robots will be placed on the same raised surface and asked to clean for two minutes. The clock will be stopped every time a robot gets stuck or falls, and the robot will be reset/restarted in order for it to clean a complete 2 minutes.

The following table shows the points that will be given for this challenge:

Falls	Points
No Falls	10
Gets Stuck	-2 Each time
Falls Down	-5 Each Time

## 7. Time/Tries to Return to Dock Challenge



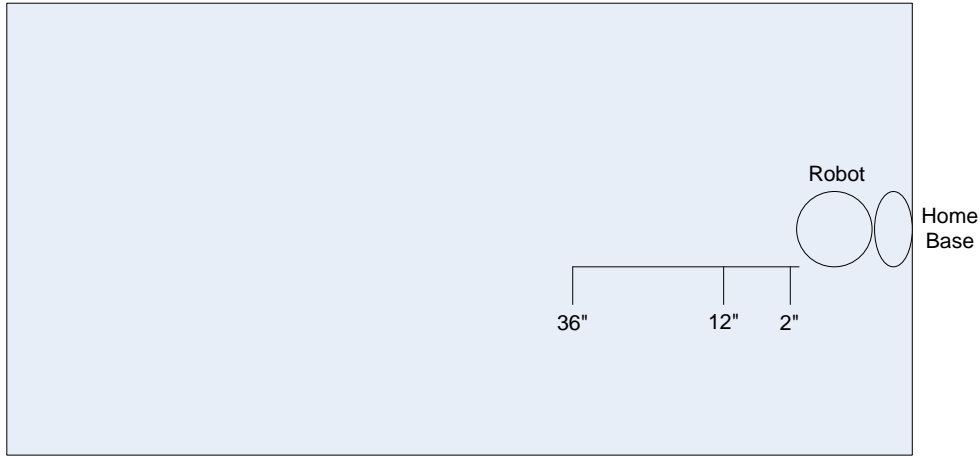
Challenge 7: Time/Tries to Return to Dock

This challenge will test the ability of each robot vacuum to return to its docking station. Each robot will be started on its dock and operated until it is on the other side of the test area. The robot will then be commanded to return to its docking station; the time for the robot to return and dock will be recorded. Points will be deducted for each failed docking attempt.

The following table shows the points that will be given for this challenge:

Time (Sec)	Points
0 $\geq$ 30	15
30 $\geq$ 60	10
60 $\geq$ 90	5
90	0
Docked First Attempt	20
Successfully Docked After Multiple Attempts	10
Failed Docking Attempt	-5
Unable to find Dock	-50

## 8. Stay on Dock Challenge

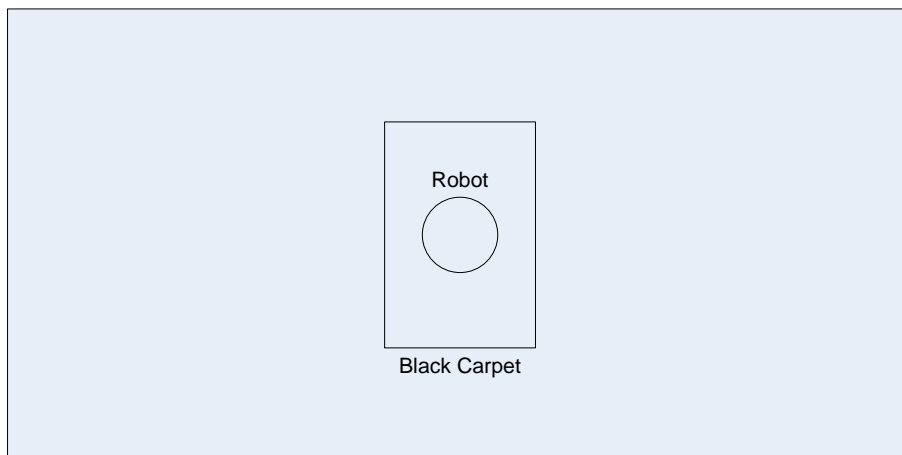


Challenge 8: Stay on Dock

This challenge will test the ability of each robot vacuum to remain on the dock if moved slightly or a lot. Each robot will be placed on their docking stations and moved 2 inches, 1 foot and 36 inches to see if each robot is able to return to the docking station by itself after it has moved. Please see the points table below that will be used for all three tests:

Dock	Points
Returns to Dock 1 Try	10
Returns to Dock Multiple Tries	5
Robot is Lost	0

## 9. Black Carpet Challenge



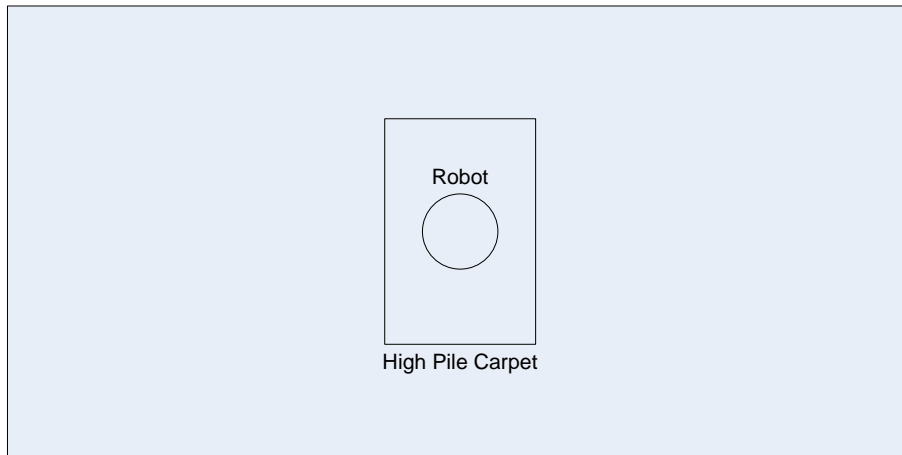
Challenge 9: Black Carpet

This challenge will test the cleaning of all robot vacuums on black carpet. Some robot vacuums are unable to clean on black carpet since they see it as a cliff. Each robot will be

asked to clean on the black carpet for 2 minutes. Points will be calculated depending on if the robot cleans without error, does not start cleaning or cleans and then gets an error. Please see the points table below:

Cleaning	Points
Cleans Without Problem	10
Cleans and Gets Error	-5
Does Not Start Cleaning	-10

### 10. High Pile Carpet Challenge



Challenge 10 – High Pile Carpet

We will test the ability of all robot vacuums to clean on high pile carpet. Each robot will be asked to clean on high pile carpet for two minutes. Points will be calculated depending on if the robot cleans without a problem, stops with an error, is unable to move properly, or if its brushes stop turning. Please see the points table below:

Cleaning	Points
Cleans Without Problem	20
Cleans and Gets Error	-10
Does Not Move Properly	-5
Brushes Stop Turning	-5

### 11. Scheduling Challenge

This challenge will test the robot vacuums ability to schedule or not and calculate points depending on how long it is to schedule a cleaning. Please see the points table below:

Scheduling	Points
Yes	30
No	-10

For the time it takes to set a schedule, the following points table will be used:

Time (Sec)	Points
0>=20	30
20>=40	20
40>=60	10
>80	0

## 12. Battery Challenge

This challenge will calculate the run time of the robot vacuums battery. Each robot will be charged fully and left in the test area for cleaning until the battery is completely dead. Robots that finish the cleaning cycle will be continually restarted until their batteries die. The total run time will then be used to calculate a ratio of optimal cleaning. This will be calculated by using results from test 1 (Time to Clean a Room challenge). We will calculate this optimal cleaning ratio since every robot navigation is different and one robot may clean for less time but, have a very optimal navigation and take less time to clean a room than other robots. Here is how this ratio will be calculated:

$$\text{Optimal Cleaning Ratio} = \frac{\text{Total Cleaning Time of Battery(min)}}{\text{Time to Clean a Room(min)}}$$

Following is the points table that will be used:

Ratio	Points
0>=5	0
5>=10	10
10>=20	20
20>=30	30
>30	40

### 13. Communicating State and Errors Challenge

This challenge will test the ability of robot vacuums to communicate errors in a clear way. Errors will be simulated, and the robots will have points calculated depending on their response to problems such as jammed brushes, jammed wheels, obstructed cliff sensors, full particle bin and dead batteries. Please see the points table for this challenge:

Error	Communication	Points
Jammed Brushes	None	-5
	Beeps	+2
	Display	+5
	Speaks	+5
Jammed Wheel	None	-5
	Beeps	+2
	Display	+5
	Speaks	+5
Obstructed Cliff Sensors	None	-5
	Beeps	+2
	Display	+5
	Speaks	+5
Particle Bin Full	None	-5
	Beeps	+2
	Display	+5
	Speaks	+5
Battery Dead	None	-5
	Beeps	+2
	Display	+5
	Speaks	+5

We will also give extra points to robots that conserve their error. For example if the robot gets an error while the user is not home, it must be able to repeat or display the error for the owner to see. Some robots will keep the error displayed without any action and other will need an action for the robot to repeat the error.

Conserving Error	Points
Conserves Error Without Action	20
Conserves Error With Action	10
Does Not Conserve Error	0

Robots are becoming increasingly sophisticated; some even communicate wirelessly via Bluetooth or through the internet to perhaps notify the owner through email, or some kind of application. While this technology isn't widespread with robotic vacuum cleaners, this Ultimate Challenge will still take it into account as a possible bonus, seen in the points table below:

Communicates Status via internet	Points
Yes	30
No	0

#### 14. Maintenance Time Challenge

The maintenance time challenge will take into account cleaning the robot vacuums brushes, dust bin and filter after a cleaning cycle and determine which robot is easiest to clean and maintain. The robots will each be made to clean the same amount of debris. Points will be calculated time it takes to do a routine maintenance of the robot.

Here is the time table that will be used:

Time (min)	Points
0>=1	50
1>=2	40
2>=3	30
3>=4	20
4>=5	10
>5	0

#### 15. Ultimate Labyrinth Challenge

This is the final challenge that will test the robots ability to clean several small sized rooms in a maze pattern and return to the docking station in the least time possible. We will start the robots cleaning in one part of the maze and place the docking station on the opposite side. Some robots might not even be able to return to the docking station and might not have enough battery power to return, or the robot may decide that it has cleaned the room and stop without it having cleaned the entire area. We will therefore need to calculate points depending on if the robot completed the maze or not and, if it was able to complete the maze, how long it took.

Please see the points tables below:

Completed	Points
Yes	10
No	-10

Time (Min)	Points
>1	25
1>=2	20
2>=3	15
3>=4	10
4>=5	5
>5	0

For more information on the Ultimate Challenge, please visit the [RobotShop Ultimate Challenge website](#).

**\*\*We are continually looking for ways to improve things at RobotShop. The methods and procedures outlined in this document may be modified or altered at any time without warning or notice.**