Topic	Planet Exploration Robot - 1	
Class Description	**Students will be introduced to the different parts of the Planet Exploration Rover. They learn to construct the Rover.**	
Class	**PRO C284**	
Class time	**45 mins**	
Goal	• Understanding the parts of a Planet Exploration Rover. • Construct the Rover using a Robot.	

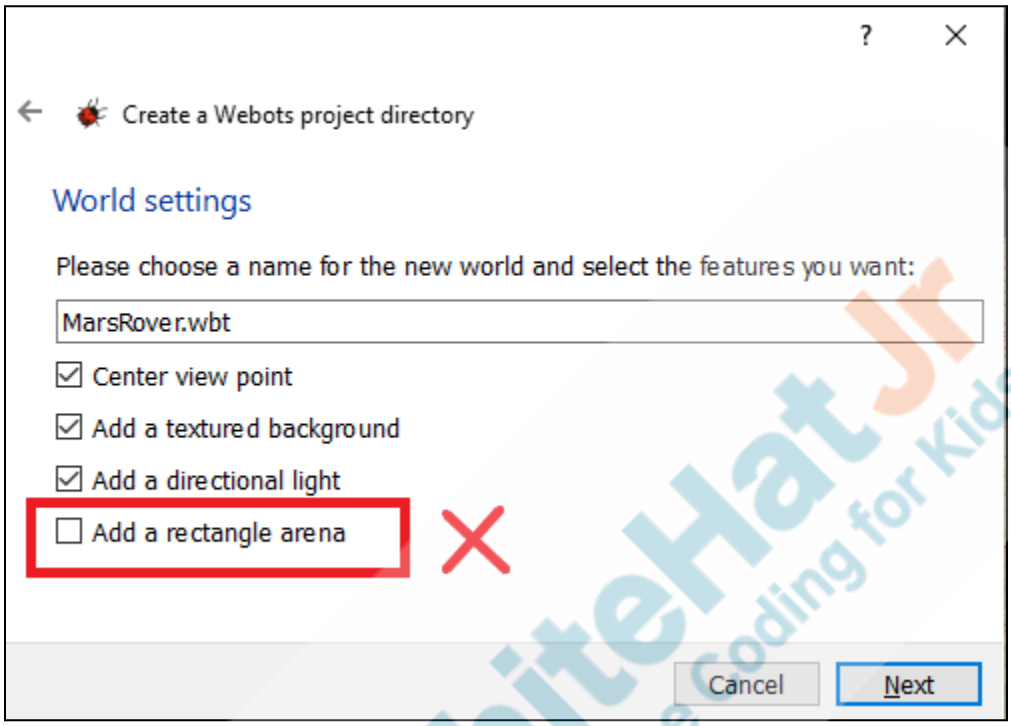
Resources Required	• Teacher Resources:
	  ○ Laptop with internet connectivity
	  ○ Earphones with mic
	  ○ Notebook and pen
	  ○ Smartphone
	• Student Resources:
	  ○ Laptop with internet connectivity
	  ○ Earphones with mic
	  ○ Notebook and pen	

Class structure	**Warm-Up** **Teacher-Led Activity 1** **Student-Led Activity 1** **Wrap-Up**	**10 mins** **10 mins** **20 mins** **05 mins**
Credit & Permissions:	**This project uses Webots, an open-source mobile robot simulation software developed by Cyberbotics Ltd.** **License**	
WARM-UP SESSION - 10 mins		
Teacher Action		**Student Action**

Hey <student's name>. How was your day? Are you excited to learn something new today? **Following are the WARM-UP session deliverables:** • Greet the student. • Revision of previous class activities. • Quizzes.	**ESR**: Hi, varied **ESR:** Yes I am excited about it! Click on the slide show tab and present the slides
WARM-UP QUIZ Click on In-Class Quiz	
Activity Details **Following are the session deliverables:** • Appreciate the student. • Narrate the story by using hand gestures and voice modulation methods to bring in more interest in students.	
TEACHER-LED ACTIVITY - 10 mins	
Teacher Initiates Screen Share	
• **Introduction to Robot Controller**	
Teacher Action	**Student Action**
Any doubts from the last class! *The teacher will clarify if there are any doubts!* So Let's deep dive into the Robots World! Do you know that scientists are exploring space and trying to understand more about the universe that we live in? We have successfully sent many satellites that orbit the earth.	**ESR:** Varied!

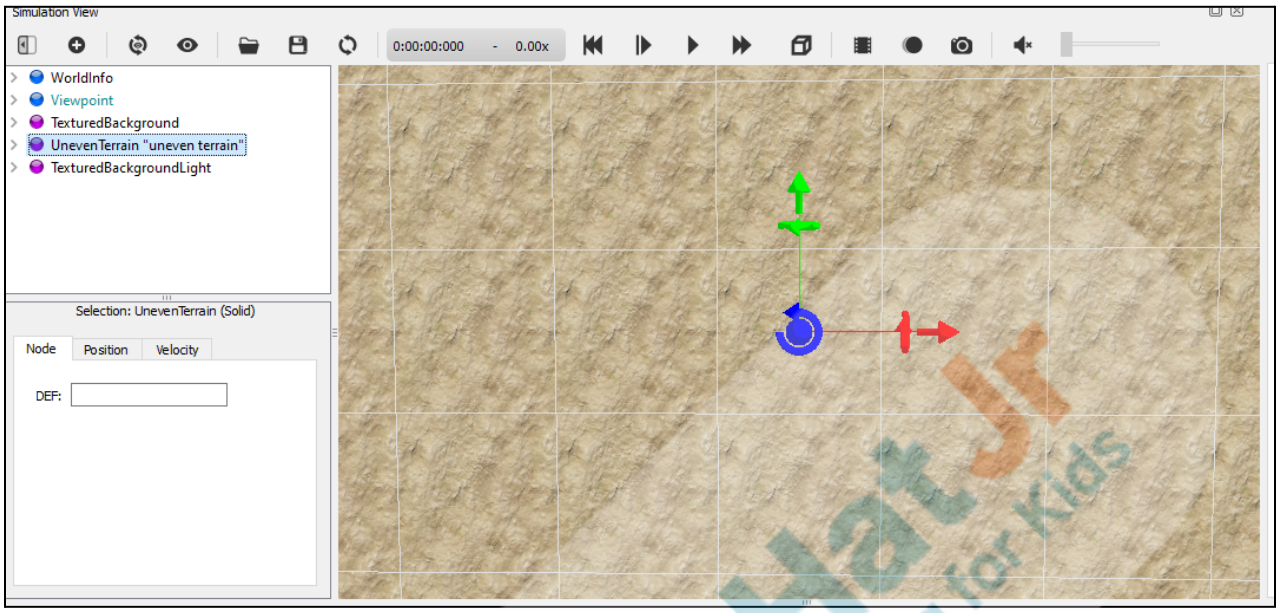
There are also many explorations that have gone to other planets to determine whether they are habitable to microbial life.They try to study the geology and habitability of the planet. Some of these missions have a robotic rover that is designed to travel on the surface of the planet. They have a huge advantage over the stationary landers that are anchored at a fixed position. A rover is basically a motor vehicle that runs on wheels and has a camera and other sensors attached to it that help it move on the surface. Can you think of the way a motor vehicle can be powered up when it is on a different planet? What kind of fuel can it use? Such rovers run on Solar energy since it is unlimited anywhere in the Solar system. Today our mission is to help scientists build a planet exploration robot. What are the different parts that a planet exploration rover would have? *Note: Students may come up with different ideas, encourage them to talk about what they think about the components of a planet exploration rover.* A planet exploration rover would definitely need 1. Wheels 2. Camera 3. Obstacle Detection sensor 4. Solar panel to power up Let's start building !	**ESR:** Varied **ESR:** Wheels to move around, a solar panel to power up, obstacle detection system, a camera to take pictures etc.
Let us open the Project using Webots. *Teacher opens Teacher Activity 1.*	

1. Note that while creating the project the rectangular arena was not selected.

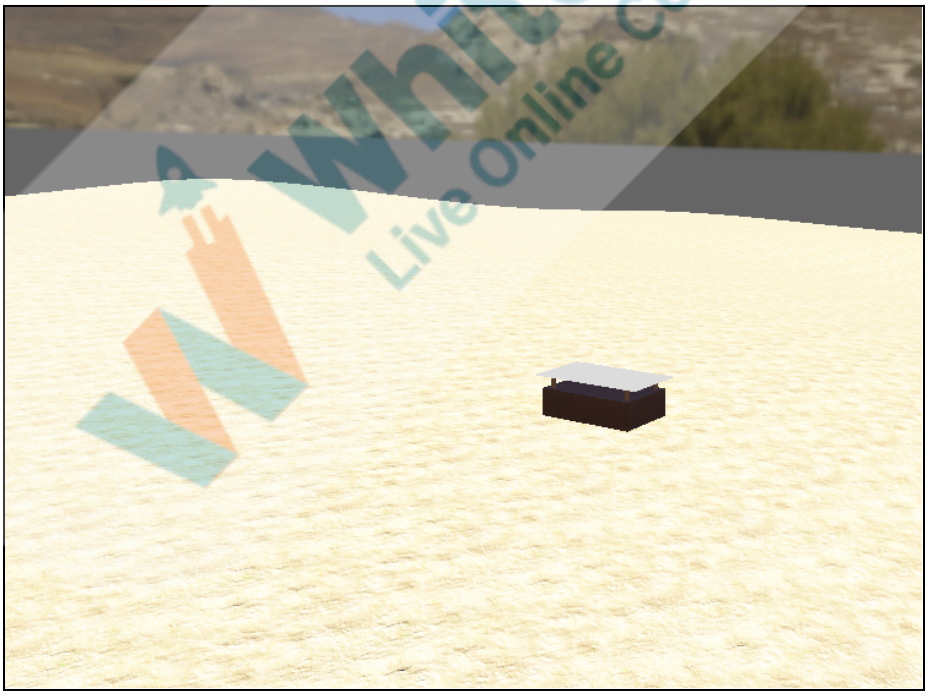


2. The floor that is added is called **UnevenTerrain(solid)**

OUTPUT:

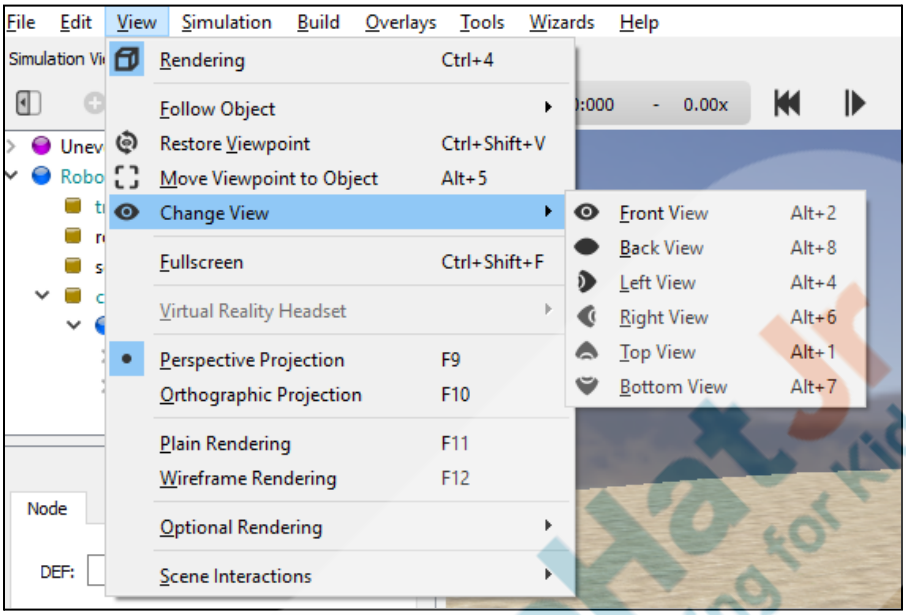


Click on drag the Terrain to get a side view.



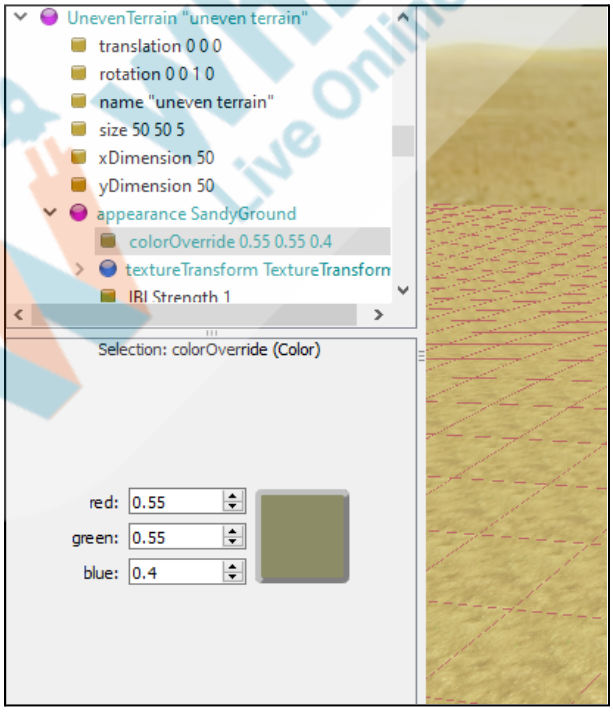
You can also change the View by clicking **View> Change View** and selecting any one

view

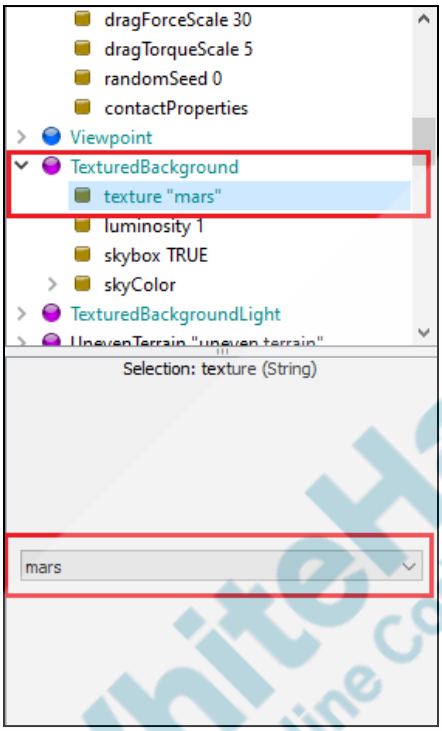


Change the color of the uneven terrain.

Uneven Terrain > appearance > colorOverride red :0.55, green :0.55, blue : 0.4

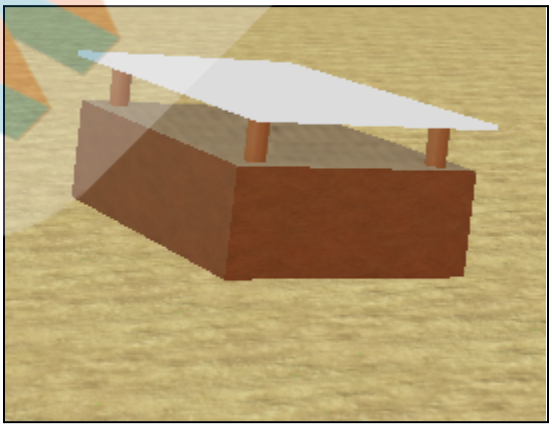


Change the background to “mars”
WorldInfo > Textured background > texture > “mars”

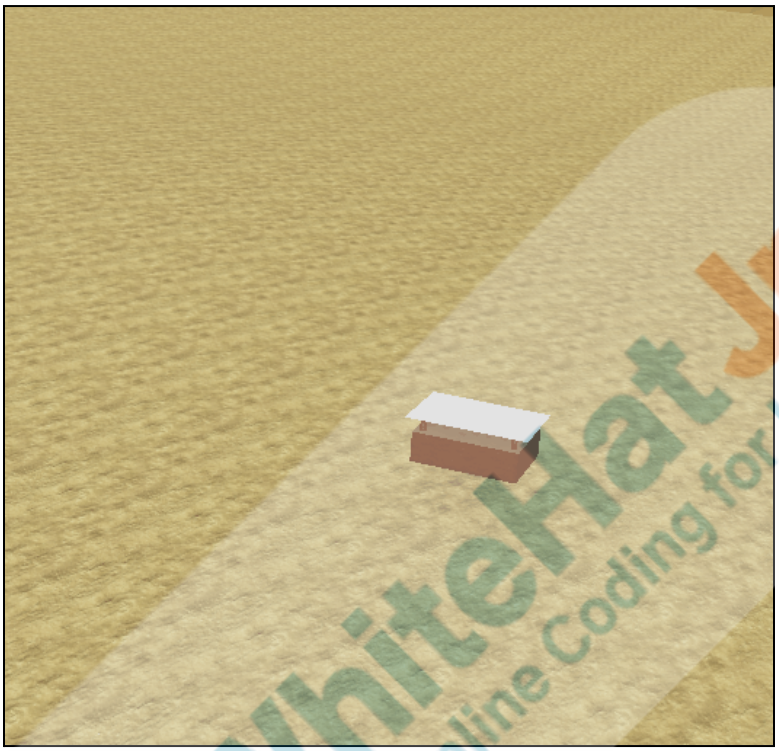


The **Robot** is already added to the project.

The basic structure of the Robot is a box. It has four supports on the top. They are called **solar_panel_support1**, **solar_panel_support2**, **solar_panel_support3** and **solar_panel_support4**. On top of the four supports there is a solar panel.



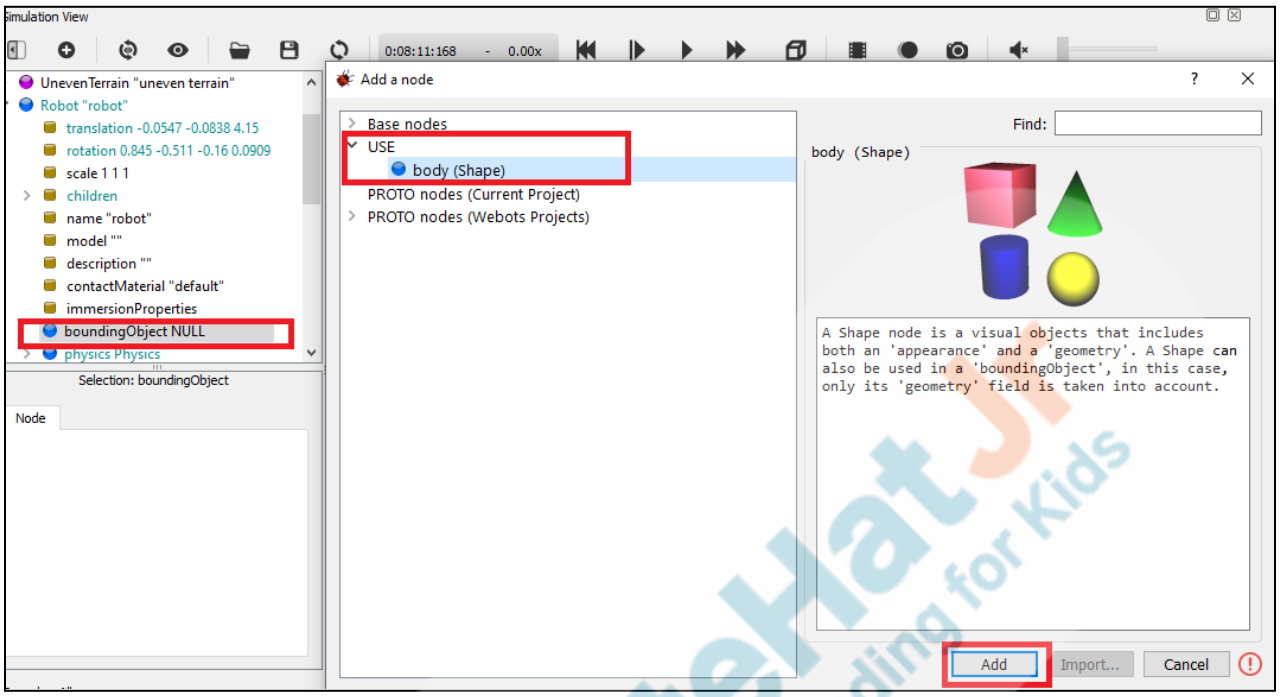
Let us click on the Play button and see what happens, the Robot falls down. That means the Physics is working. There is an issue even now, it fell down below the Terrain.



To resolve this we have to add a bounding object to the Robot.

*Note to teacher : To bring the robot back up, change the translation to **x: 0, y: 0, z :0** and click on **Robot.** Now pull up the blue arrow once again.*

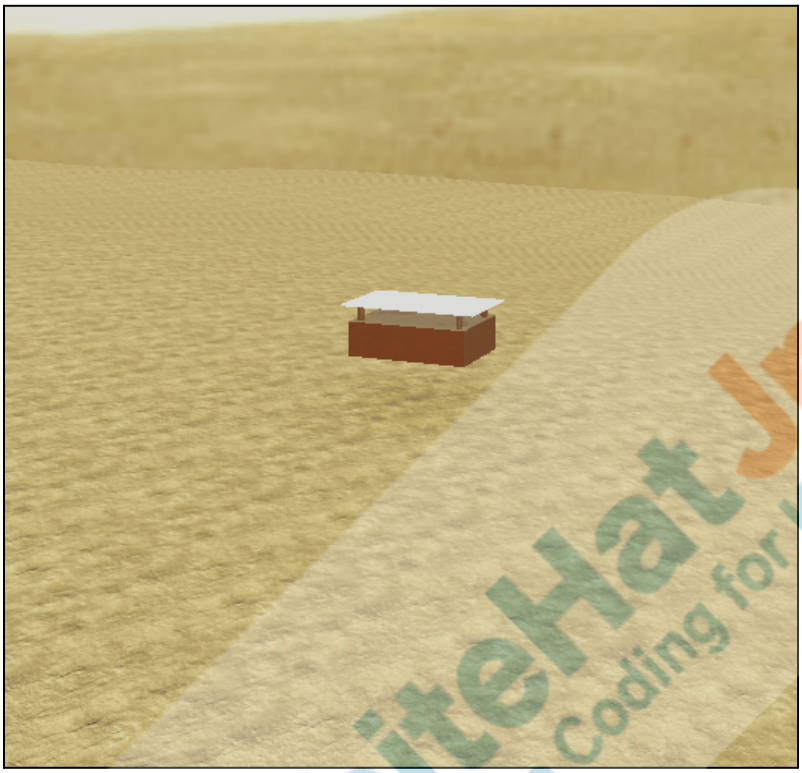
- Double click on Robot> boundingObject
- Select USE > body (Shape)
- Click on Add



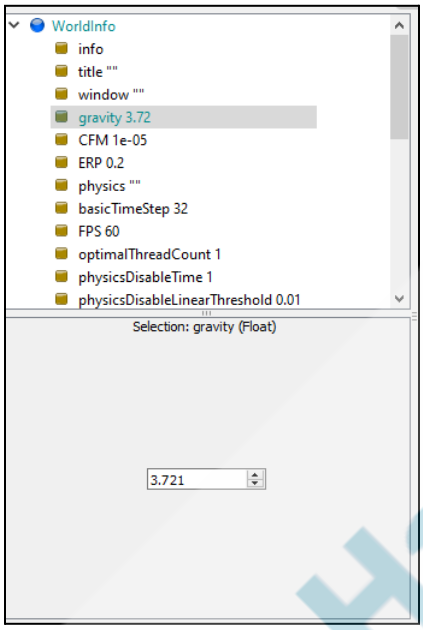
OUTPUT:

We can see a faint white line around the box confirming that the bounding object has been added.

Now if you pull up the Robot and click on Play, we can see that the Robot does not fall beyond the terrain.



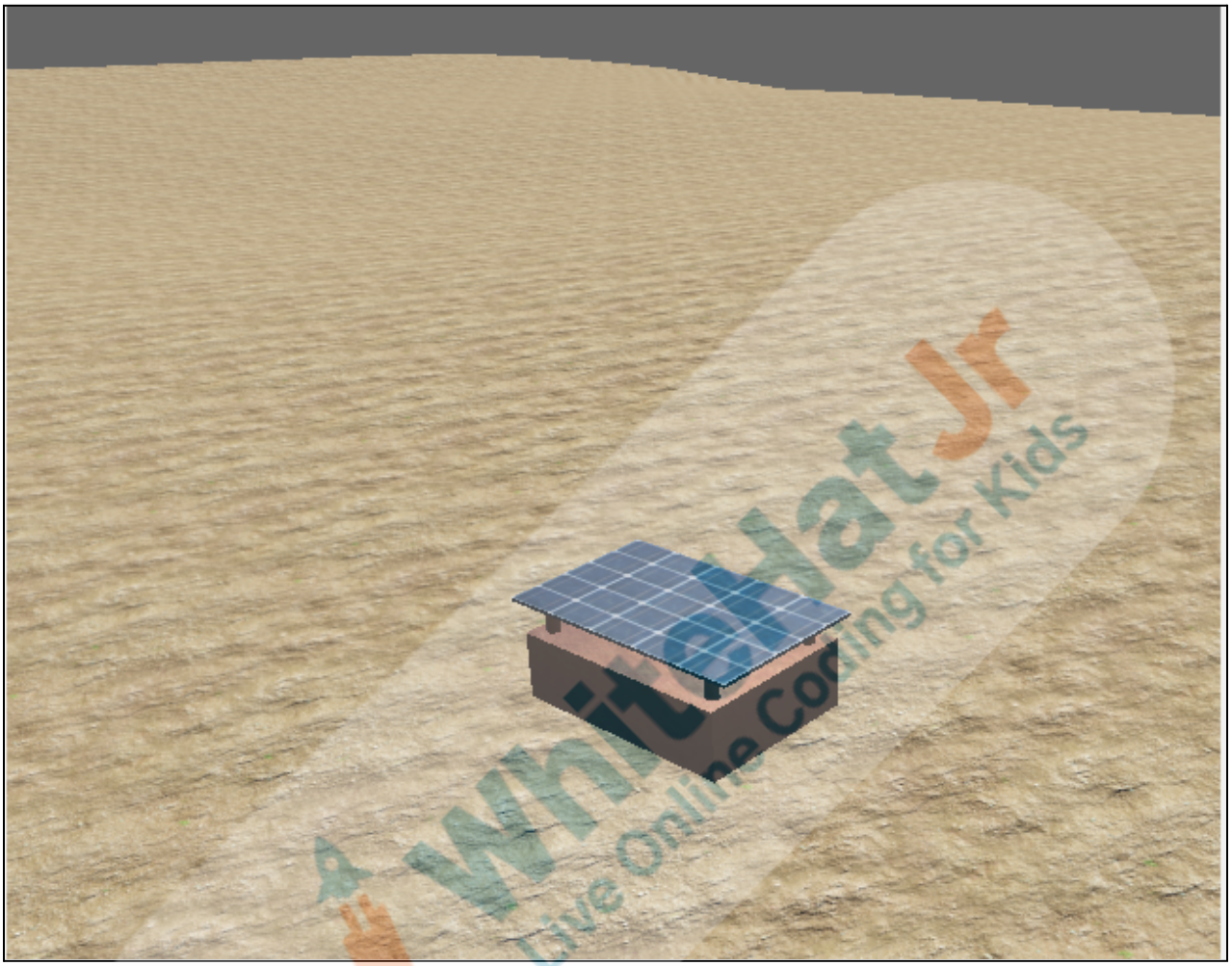
We have to change the gravity of the Terrain since by default the value it takes is the value of earth's gravity. Do you know what the gravity of earth is? Perfect. The gravity of the planet Mars is lower than that of earth. It is equal to 3.721 m/s². So let's set the gravity of the terrain to be that of Mars and the mass of the robot.	**ESR:** 9.807 m/s²
Click on **WorldInfo> gravity** Set the value to **3.721m/s²**.	



The solar panel is while in color. Let us change the texture of the panel so that it looks like a proper solar panel. We can change the appearance of the solar_panel to **SolarCell.**	**ESR:** The solar panel

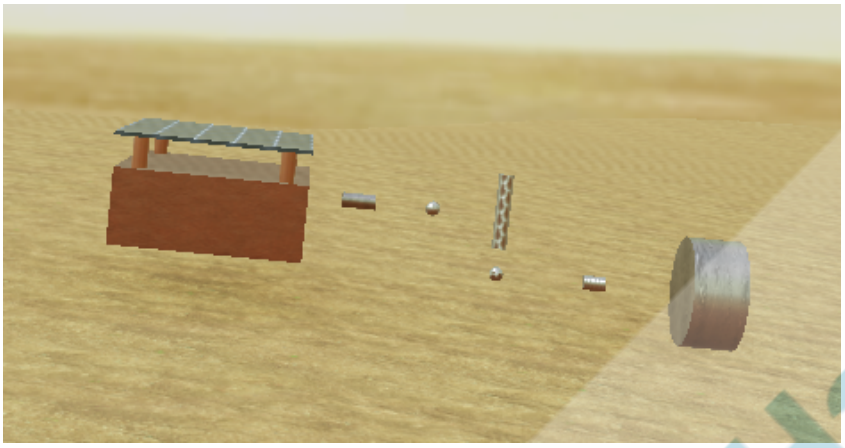
Under **solar_panel > children** select **panel** (**Shape**)
Set the following properties
appearance : SolarCell

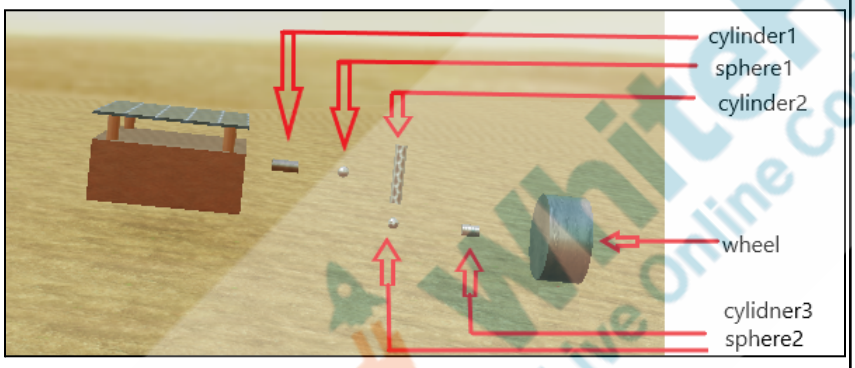
OUTPUT:



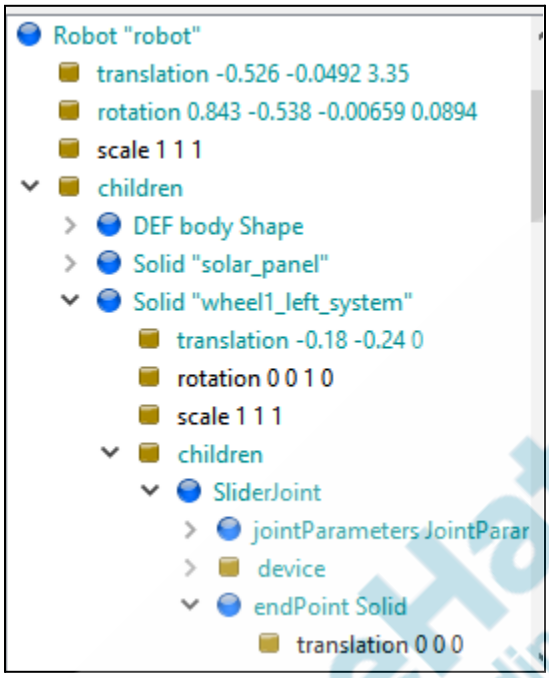
Doesn't it look great ? To complete the rover, what do we have to add next? That is right. To add the wheels, do you remember which joints we had used earlier? Let us add slider joints to the base of the box and add wheels to it. The parts of the wheel would be three cylinders attached	**ESR:** Yes! **ESR:** The wheels of the rover. **ESR:** Hinge joints.

by two spheres. The third cylinder is attached to the wheel which is a cylinder. The center of this cylinder is the axis of rotation of the wheel.



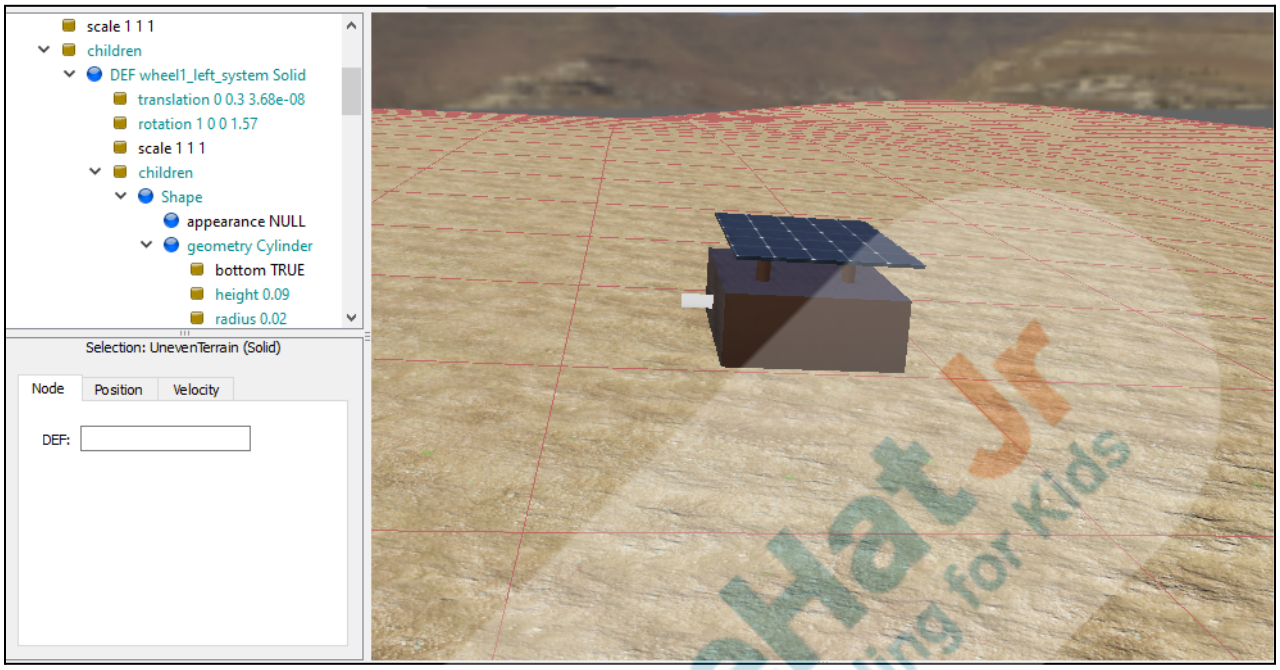


Robot > children > Solid (name : left_wheel_system1) > children > SliderJoint
Set the following parameters
jointParameters : Joint Parameters
Device : Linear Motor
endPoint : Solid



Now let us add the first cylinder "**cylinder1**".

Robot > children > Solid (name : left_wheel_system1) **> children > Solid > children** (name : cylinder1) **Shape > geometry - Cylinder.**
height : 0.09
radius: 0.02



Set the **appearance** as DamascusSteel (PBRAppearance)

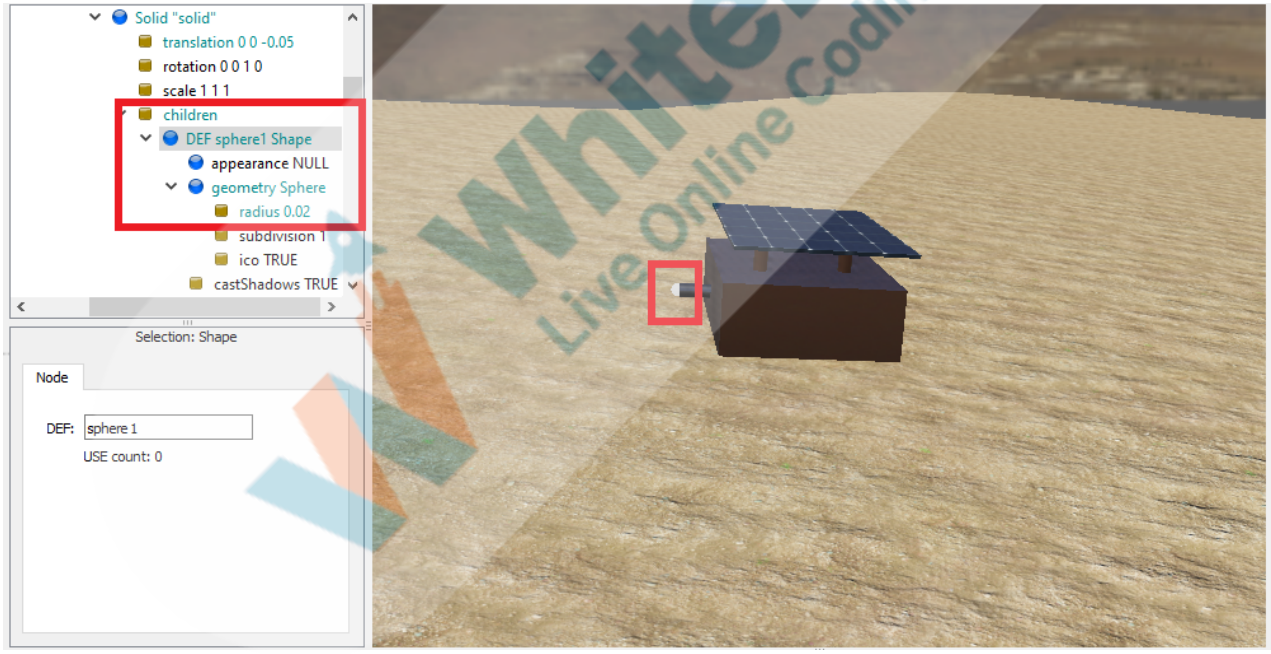
<table>
<tr>
<td>What do we add next?

Yes, now it's time to add the first sphere that attaches cylinder1 and cylinder2.
This sphere is added as a child of cylinder1.
Can you tell me the steps involved?

So let’s proceed</td>
<td>ESR: Sphere between cylinder1 and cylinder2.

ESR: Right click on the children tab of Solid cylinder1 and click on Add New. Add a Solid and under that Add a Shape sphere to it.</td>
</tr>
<tr>
<td colspan="2">Robot > children > Solid (name : left_wheel_system1) > children > Solid (name: cylinder1) > children > Solid > children > Shape > geometry - Sphere (name : sphere1)

radius: 0.02

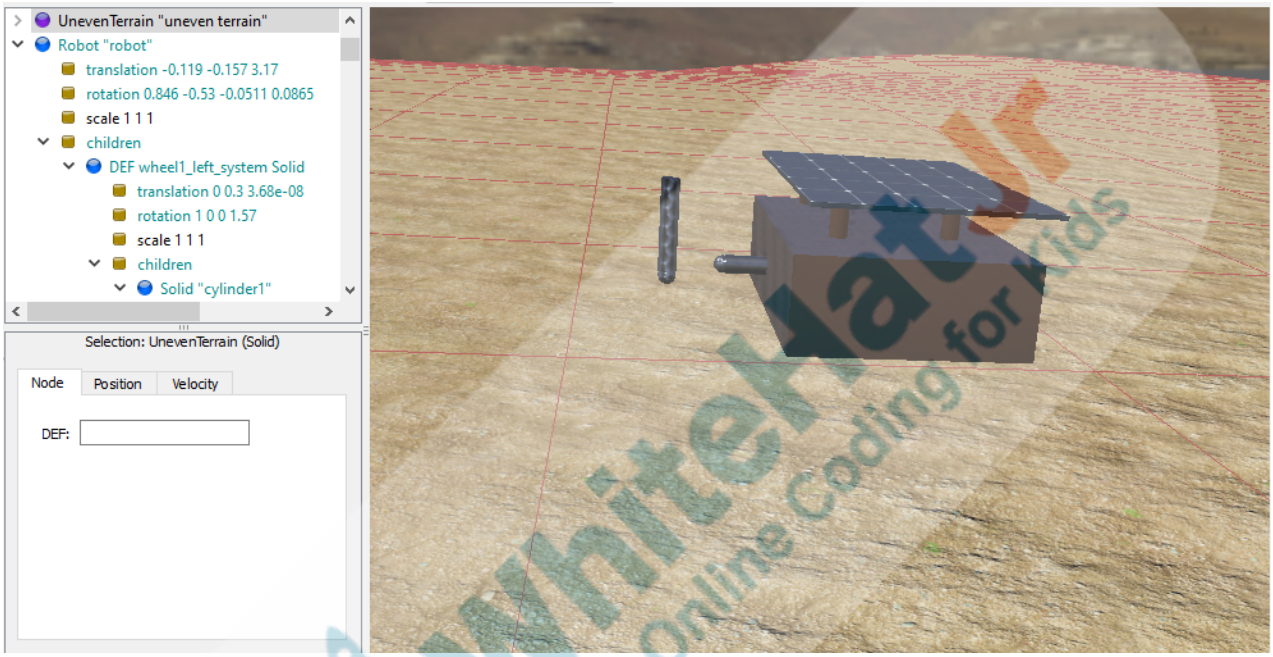
 

Change the appearance to Brushed Steel</td>
</tr>
<tr>
<td>Now let us add the second cylinder2. There is a sphere attached to the tip of cylinder2. So we can Copy cylinder1</td>
<td></td>
</tr>
</table>

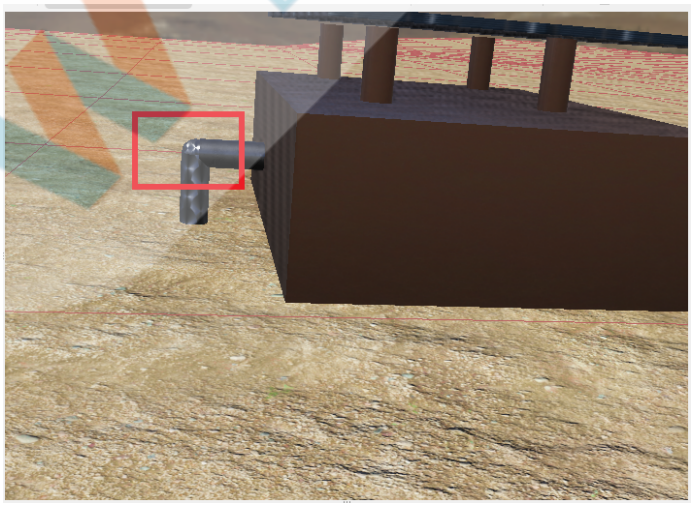
and Paste it as a child of Solid of cylinder1.

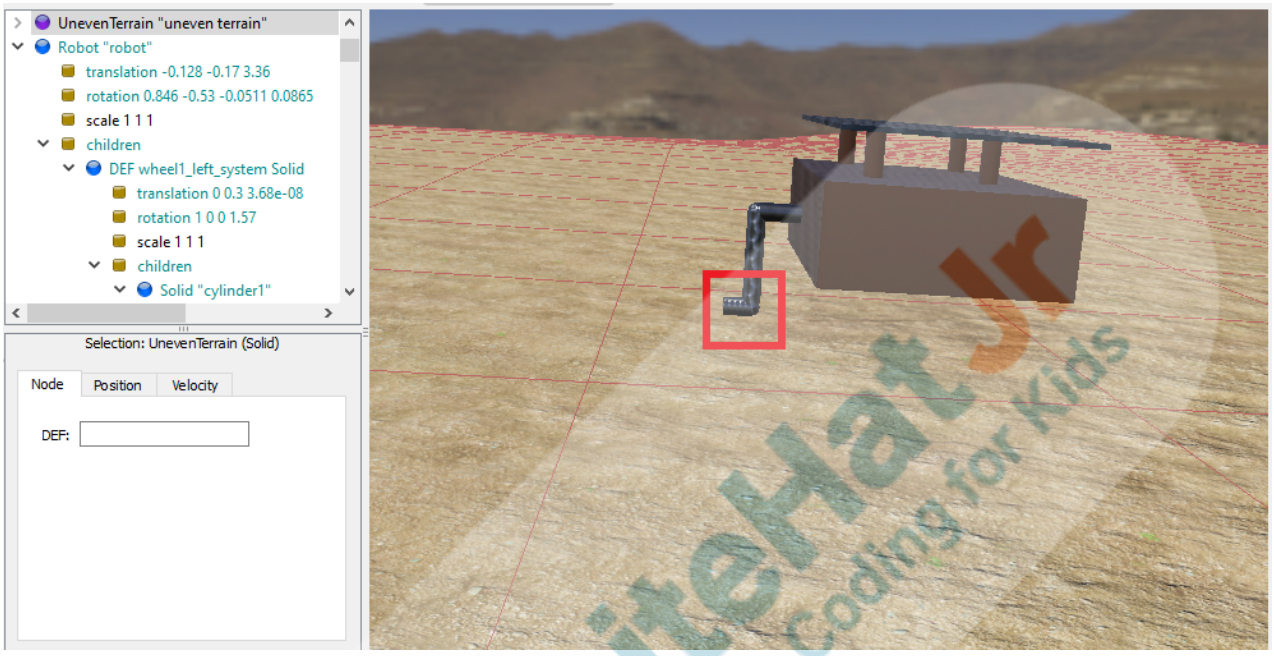
Make sure to rotate cylinder2 by 90 degrees so that it faces down.

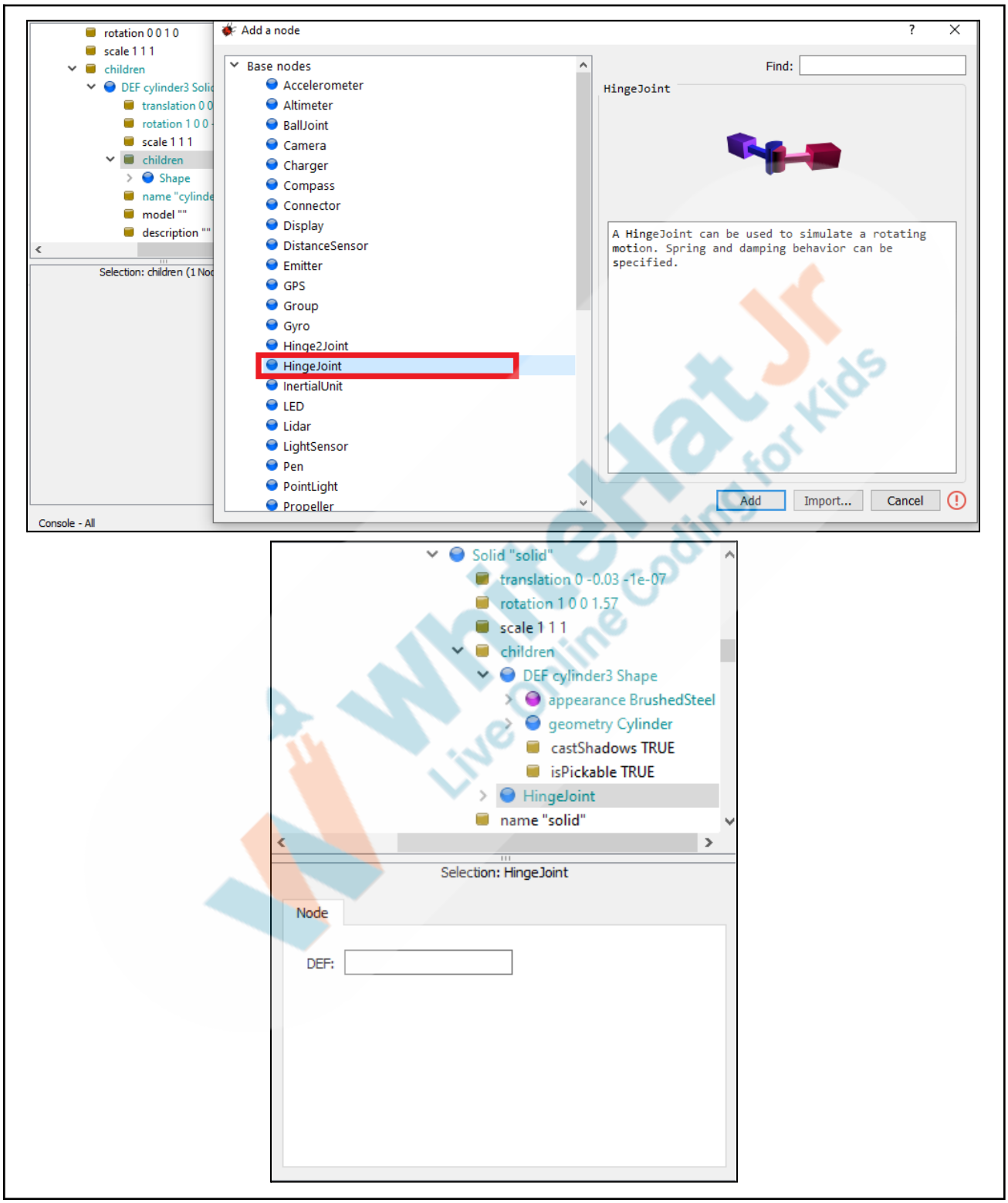
cylinder2 tilted at 90 degrees



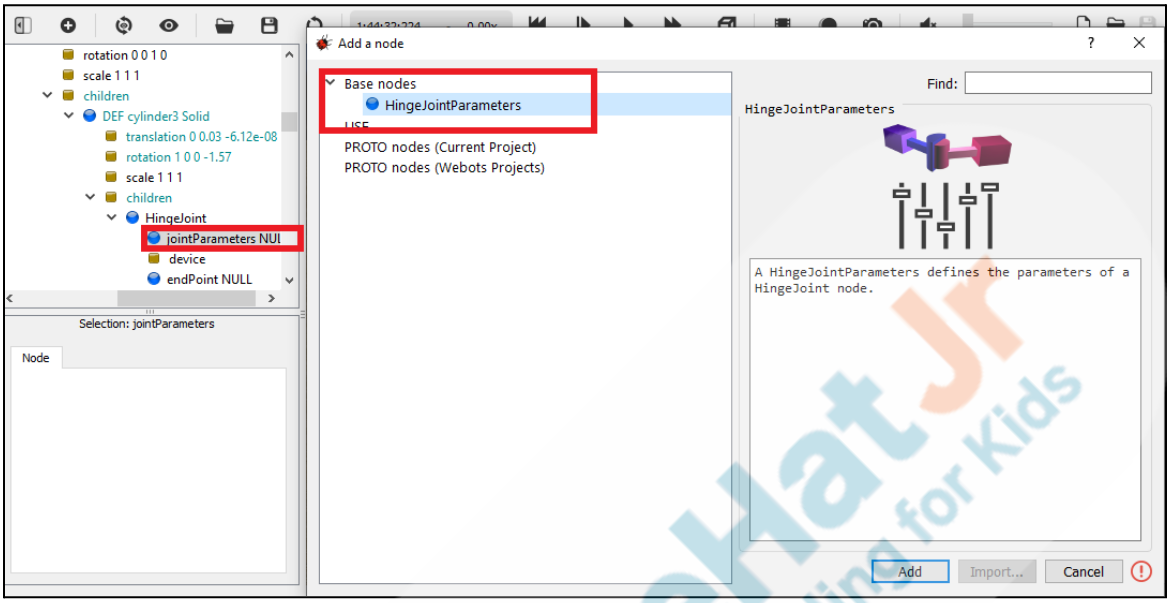
Position it properly at the tip of sphere1 so that it forms an **L-shape**.



Similarly, add cylinder3 to the tip of sphere2 as a child to cylinder2.	
	
As a last component let us add the wheel. Here we have to add a HingeJoint. What is the shape of the wheel that we have in the Rover?	**ESR:** Cylinder

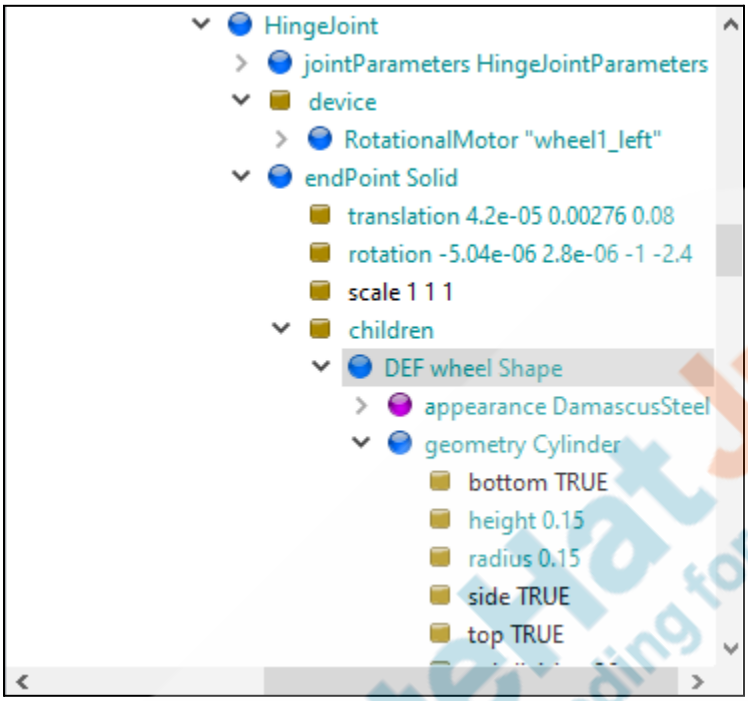


Set the **jointParameters** as **HingeJointParameters**

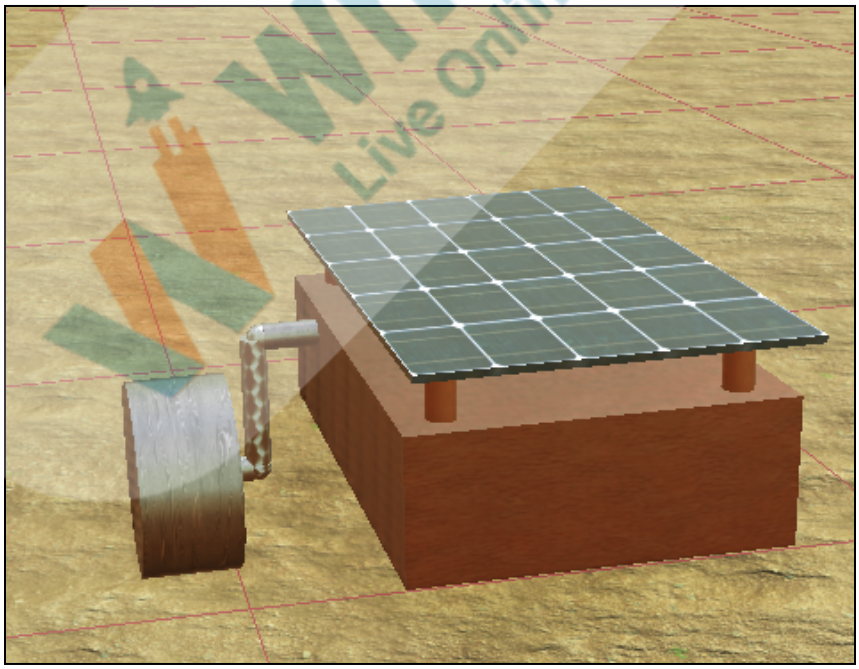


Set the following properties
position : 2.4
axis - x: 0, y: 0, z : 1

Set the following properties for the Hinge Joint
device : Rotational Motor
endPoint > children : Solid
endPoint > children : Solid > children > Shape - geometry - Cylinder
- appearance - DamacusSteel



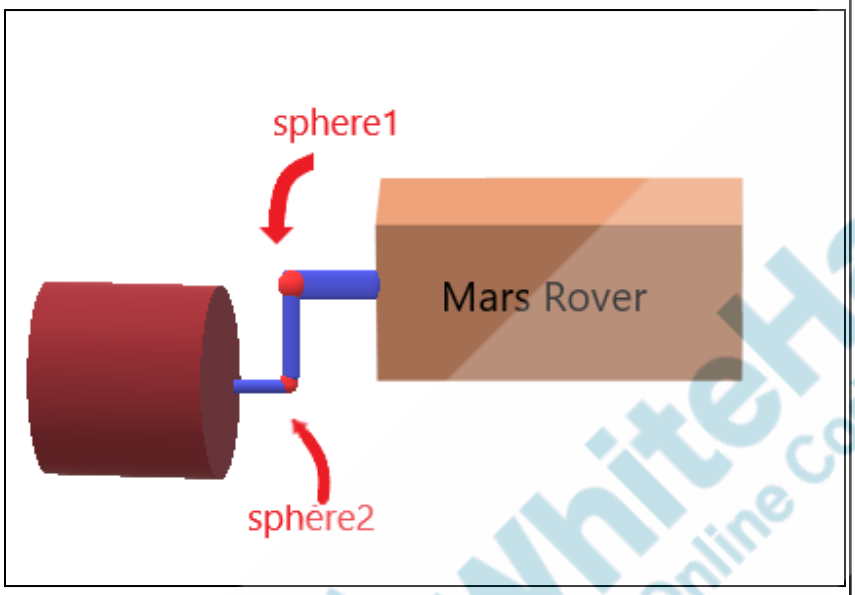
OUTPUT:



Let us click on the Play button and see what happens. The entire structure falls down and topples over. What should we do to stop this toppling over?	**ESR:** Add all four wheels so that the structure is complete.
Now it is your time to create. Can you create the remaining wheels? You will also have to add the solar panel on top of the four pillars.	
Teacher Stops Screen Share	
So now it's your turn to create. Please share your screen with me.	
Can you create the remaining wheels and the solar panel on top of the four pillars? Let's try. I will guide you through it.	**ESR :** Yes
STUDENT-LED ACTIVITY - 20 mins	
• **Ask the student to press the ESC key to come back to the panel.** • **Guide the student to start Screen Share.** • **The teacher gets into Full Screen.**	
Student Initiates Screen Share	
ACTIVITY • **Add the remaining three wheels** • **Add the solar panel on top of the four pillars.**	
Teacher Action	**Student Action**
The teacher helps the student to download boilerplate.	Student downloads **Student Activity 1** in **Webots**
Can you look at the rover and tell what are all the missing parts?	**ESR:** The solar panel and

Let us add the three wheels first so that the structure stands up straight.

We can add one wheel on the right side. Later we just have to copy and paste the two existing wheels and change their position.



Note to teacher : Guide the student to add the right wheel just like the left wheel. The position of each child node is relative to the position of its parent node.

The .wbt file of the reference file can be opened in Visual Studio Code or any other text editor to check the position of each node.

the three wheels.

Position of cylinders and spheres

Name	**x**	**y**	**z**
cylinder1	0	0	-0.05
sphere1	1	0.1	1.79608e-07

cylinder2	0	0	-0.11
sphere2	0	-0.3	9.99999e-08
cylinder3 > children > HingeJoint	0.000415459	0.00116845	0.080005

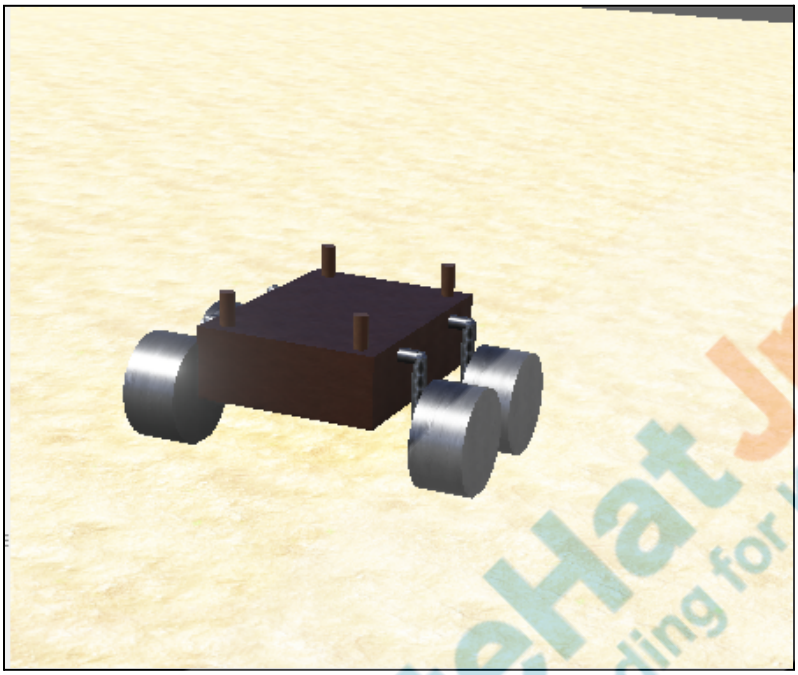
Now you can copy the wheel_1_left_system and paste it. Name it wheel_2_left_system and change the position by changing the translation values.

Similarly copy the wheel_1_right_system and paste it. Name it wheel_2_right_system and change the position by changing the translation values. .

Position of the 4 wheels

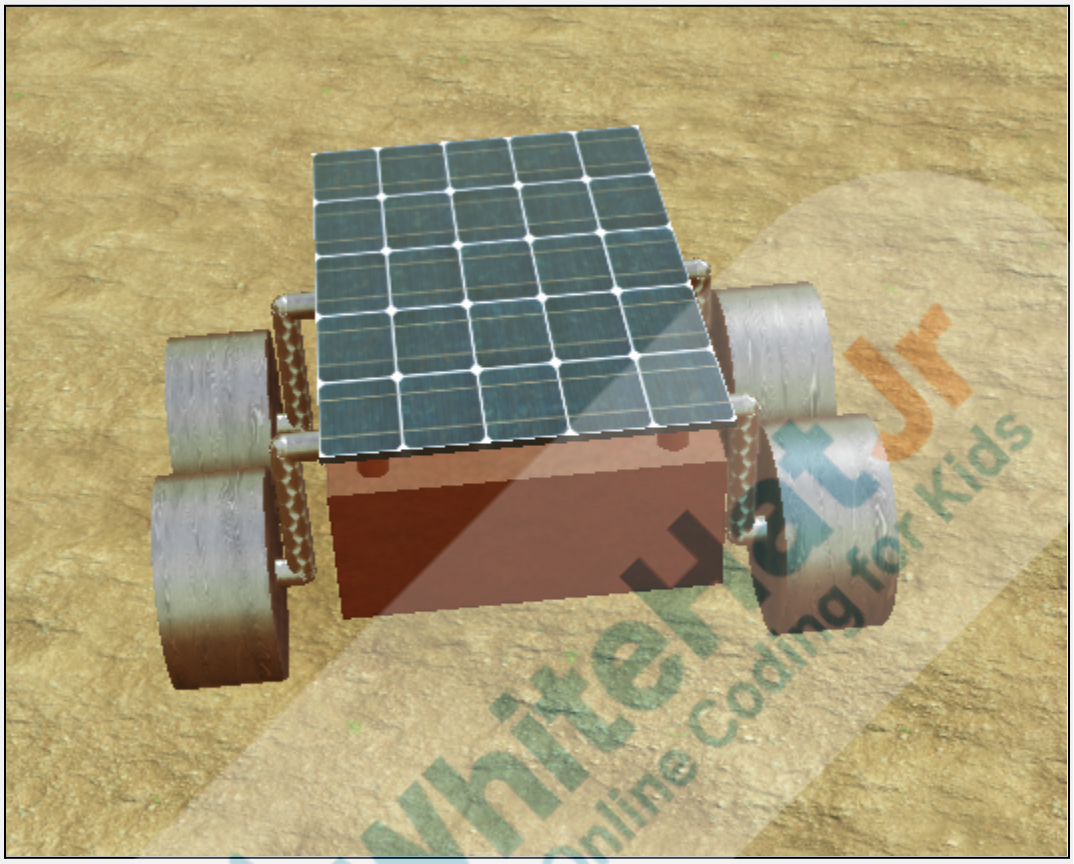
Wheel name	translation x	translation y	translation z
wheel_1_left_system	-0.18	-0.24	0
wheel_2_left_system	+0.18	-0.24	0
wheel_1_right_system	-0.18	+0.24	0
wheel_2_right_system	+0.18	+0.24	0

OUTPUT:



Now as a final step add the solar panel to the top of the four pillars.

Note to teacher : Guide the student to add the solar panel as described in TA



Wonderful, now the rover is complete and is looking wonderful.	
So we're done with our full fledged planet exploration Rover.	

Teacher Guides Student to Stop Screen Share

WRAP-UP SESSION - 05 mins

Activity details

Following are the WRAP-UP session deliverables:

- Appreciate the student.
- Revise the current class activities.
- Discuss the quizzes.

WRAP-UP QUIZ
Click on In-Class Quiz

Activity Details

Following are the session deliverables:

- Explain the facts and trivia
- Next class challenge
- Project for the day
- Additional Activity (Optional)

FEEDBACK

- **Appreciate and compliment the student for trying to learn a difficult concept.**
- **Get to know how they are feeling after the session.**
- **Review and check their understanding.**

Teacher Action	Student Action
You get "hats-off" for your excellent work! In the next class, we will learn to move the rover using the keyboard.	*Make sure you have given at least 2 hats-off during the class for:* 

PROJECT OVERVIEW DISCUSSION
Refer the document below in Activity Links Sections

Teacher Clicks	✖ End Class
ADDITIONAL ACTIVITIES (Optional)	
Additional Activities	

ACTIVITY LINKS		
Activity Name	**Description**	**Links**
Teacher Activity 1	Teacher boilerplate code	https://github.com/procodingclass/PRO-C284-Teacher-Boilerplate
Teacher Reference 1	Reference Code	https://github.com/procodingclass/PRO-C284-Reference-Code
Teacher Reference 2	Project	https://s3-whjr-curriculum-uploads.whjr.online/764de91f-b8f3-4d8b-93d7-0c3567ccb33d.pdf
Teacher Reference 3	Project Solution	https://github.com/procodingclass/PRO-C284-Project-Solution
Teacher Reference 4	In-Class Quiz	https://s3-whjr-curriculum-uploads.whjr.online/6afe2eaa-5e8a-4aab-b406-718b9f6990a0.pdf
Student Activity 1	Boilerplate Code	https://github.com/procodingclass/PRO-C284-Student-Boilerplate