

# **Emini Physics World Designer**

Version 1.3.4

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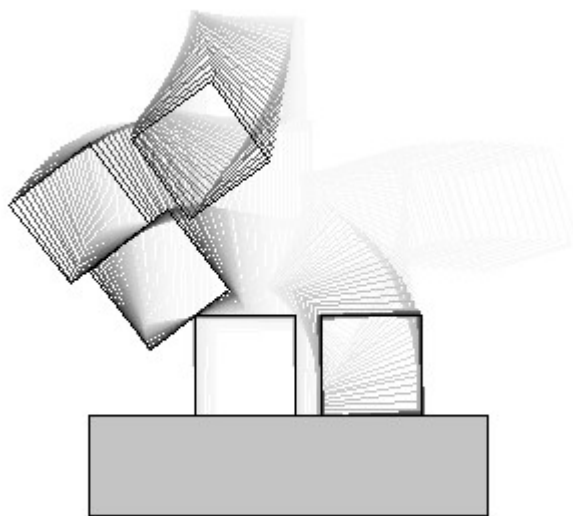
# Introduction

The Emini Physics Engine is used to create realistic physics effects for games and applications. The World designer greatly helps in designing, testing and maintaining complete physics environments. This graphical tool allows fast development of worlds and detailed optimisations, making coding of the world environment obsolete.

The physical environment can be tested by simulating it in an interactive mode, where external forces can be applied.

To understand the terms used in this document please read the Emini Physics Engine documentation.

The section First Steps illustrates the first steps in creating a physical environment.



# Definitions

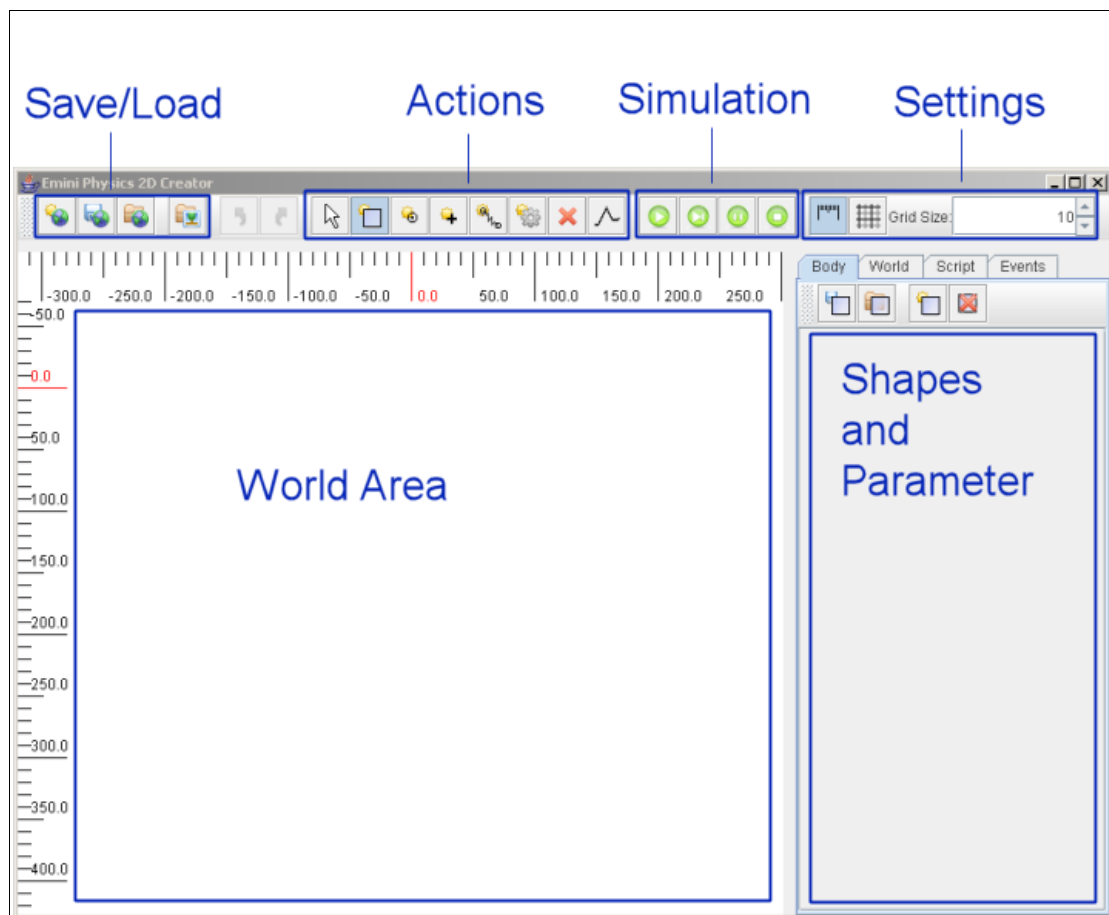
A rough overview of the used terms and definitions. For more detailed information see also the Emini Physics Engine documentation.

- World – the complete physics environment including all bodies, constraints and simulation parameters are referred to as the world.
- Body – Each physical rigid body is referred to as body. Each body is of a certain type, defining its physical properties. The body itself knows its state in the physical world (e.g: position, velocity, ...).
- Shape – the shape is a body type. It defines a shape of a body and its physical properties (friction, mass, elasticity).
- Constraint – each factor that forces a rule upon one or more bodies is referred to as constraint (e.g: joints, springs, motors).

## Overview

The designer is divided in several areas. The large main area “World Area” represents the world. Here bodies can be added, removed and manipulated. The right area “Shapes and Parameter” is used to define and manage shapes, events and simulation parameters like gravity.

The application is controlled by the top toolbar only.



# First Steps

This is a brief guide to a simple world setup. It illustrates the main controls and concepts. We will create a small car driving down a ramp. This sample is shown in the video tutorial.

## Create Landscape

We start with an empty world. First we want a ramp for the car to drive on. We need to select the Landscape tool for this.



Then click and drag on the draw area for a ramp. Additional landscape segments allow better control of the exact form.

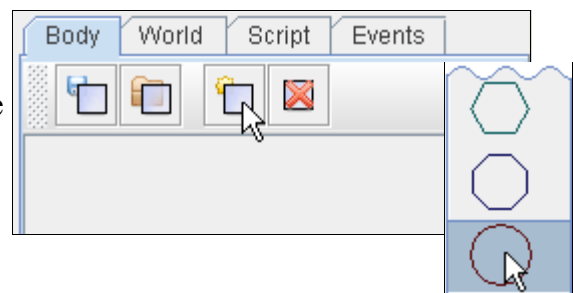


The shading on the landscape segments indicates the face. From the black side it is impenetrable, from other side bodies can move through the line. A single line indicates solid behavior from both sides. Clicking on the green symbol next to each segment toggles the face mode.

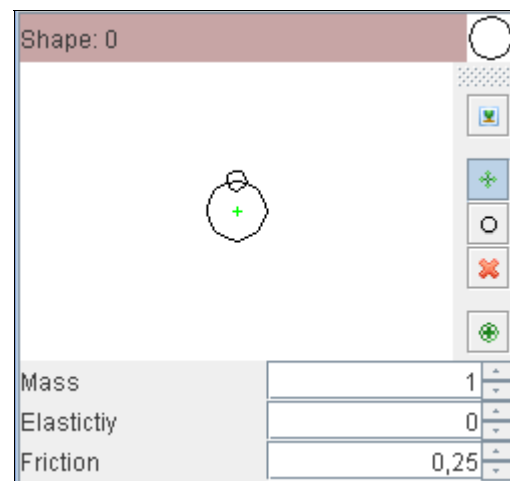
## Create Shapes

Before we can add some bodies, we first need some shapes. We need wheels and a chassis for the car.

Click on the “New Shape” button and select the circle from the popup menu.



The circle appears and we can modify its parameters. Here we can leave them as they are.

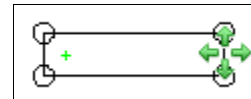
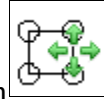
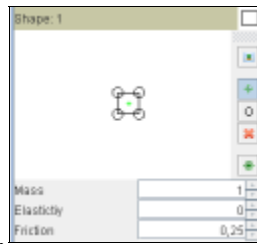


Now we need a second shape for the chassis. We will simply use a rectangle for this.

We create another shape. This time we select the square.

By dragging the right border to the right, the shape becomes a rectangle. We could also move the vertices.

The shape is not centered now. The center is indicated by the small green cross. That can lead to unexpected simulations (the physical interpretation is non-uniform mass distribution). To avoid that we center the rectangle by pressing the according button.

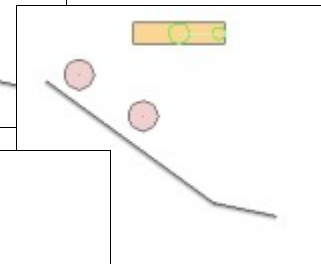
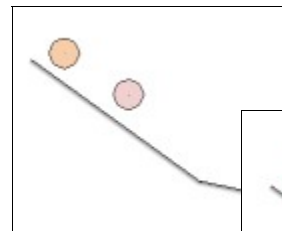


## Create Bodies

We have created the shapes and now we want to build the car. First we select the circle (Shape 0) again. Then we select the “New Body” tool from the toolbar.

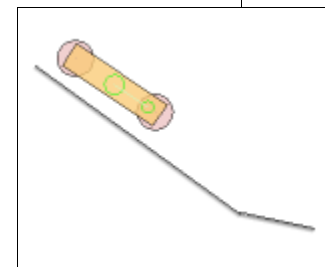


Now we can position the wheels on the top end of the ramp. The bodies are added by clicking in the draw area.



The next step is to add the rectangle. At first we can place it anywhere. By using the green circles we can then rotate and move it to the correct position.

By dragging the green circle in the center, the body is moved. The other circle rotates the body.

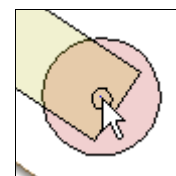


## Create Joints

Now we need to create the axes for the wheels. This is done by a loose joint. We select the tool from the toolbar.



Now we can place the joints by clicking in the axle positions. The bodies should overlap there so that a simple click can joint those bodies.



## Test Simulation















The first simple world is now done and we can test it. Start the simulation by pressing the play button. Stop ends the simulation and returns to the edit mode.









# Reference

This chapter presents detailed reference about all functions of the designer.

## Toolbar

<b>New World</b>		Creates a new world.
<b>Save World</b>		Saves a world to file (.phy).
<b>Load World</b>		Loads a world from file (.phy).
<b>Undo</b>		Undo the last action.
<b>Redo</b>		Redo the last action.
<b>Select</b>		Chooses the Selection tool. In this mode physical elements can be selected and manipulated.
<b>New Body</b>		Selects the New Body tool. Bodies can be created by clicking at the desired position.
<b>New Joint</b>		Selects the New Joint tool. Joints can be created by clicking on two overlapping bodies.
<b>New Fixed Joint</b>		Selects the New Fixed Joint tool. Like above, except the created joint is fixed.
<b>New Spring</b>		Selects the Spring tool. Springs can be created by first clicking at the first anchor position then at the second.
<b>New Motor</b>		Selects the Motor tool. Motors can be added to y body by clicking it.
<b>New Particle</b>		Selects the particle tool. A new particle emitter is created by clicking on the world.
<b>Delete</b>		Selects the Delete tool. Physical elements can be deleted by clicking them.
<b>Landscape</b>		Selects Landscape tool. Landscapes can be drawn by clicking and dragging each segment.

<b>Play</b>		Starts the simulation. Enters the simulation mode.
<b>Single Step</b>		Performs a single simulation step. Enters the simulation mode.
<b>Pause</b>		Stops the simulation, but stays in simulation mode.
<b>Stop</b>		Stops the simulation and leaves the simulation mode.
<b>Ruler</b>		Toggles the position ruler.
<b>Enable Grid</b>		Toggles the grid for precise positioning.

Minor actions can be performed in some other modes as well. E.g: In the “New Body” mode existing bodies can be moved and rotated.

## World Area

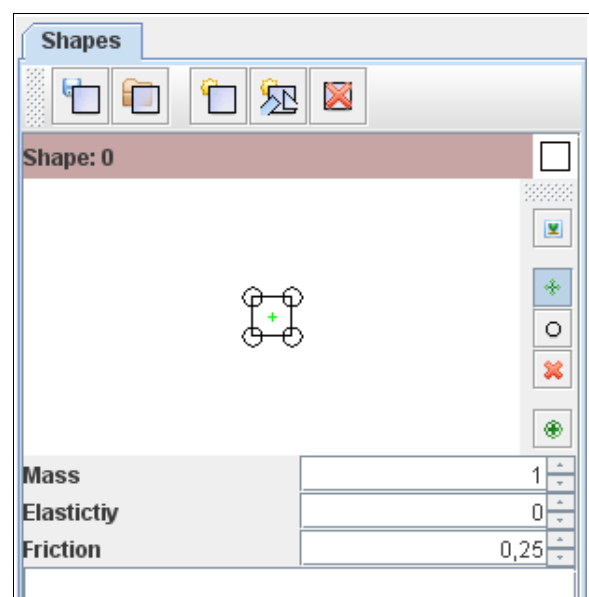
The world area contains all objects (bodies, constraints, events). It can be zoomed using the mouse wheel and moved dragging the mouse, when not hovering over any object (the mousepointer shows a hand).

## Shapes

The shape tab of the right side panel allows shape creation and manipulation.

Shapes can be saved and loaded using the according buttons. The save button saves a world file containing all shapes. The load button loads aall shapes from any world file.

The new shape button creates a new shape. A popup menu shows up with a selection of predefined shapes. The delete button deletes the currently selected shape.

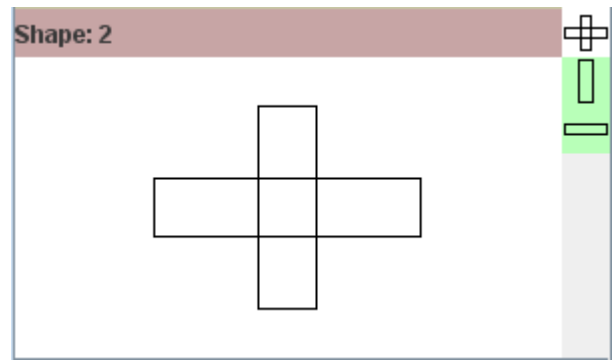




The button “New Combined Shape” creates a special shapes. two or more normal shapes are merged into one complex shape. The required shapes can be selected on the right side of the shape panel.

The physical properties associated with the shape (friction, mass, elasticity) can be modified in the fields below the shape image.

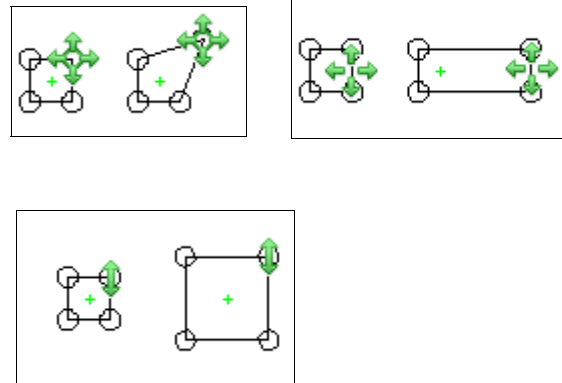
In the textfield below custom data can be entered. This data is retrieved when the world is loaded. It can be read and stored in a custom userdata class. See javadoc for further information.



## Shape manipulation

The shape draw area behaves like the world draw area with respect to zooming and moving.

The vertices of the shape can be moved by dragging them. By dragging a face, this can be moved directly. Holding down the Ctrl key while dragging a vertex scales the complete shape.



### Background Image



Displays a background image for this shape.

### Move



Selects the move tool. In this mode the vertices and faces can be moved.

### New Vertex



Selects the New Vertex tool. In this mode vertices can be added by clicking at any position on a face.

### Delete Vertex



Selects the Delete tool. In this mode vertices can be deleted by clicking on them.

### Center shape

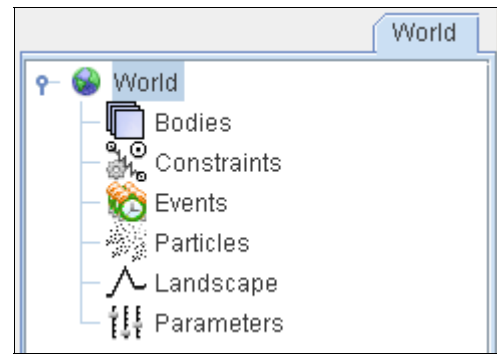


Moves all vertices of the shape so that the origin (small green cross) is the center of gravity.

## World Info Panel

The world tab on the right side panel shows the contents of the world and allows detailed edit of all object. The actual descriptions follow in the section for the respective object.

*Note:* The body ids are ordered for optimized reading of world files. this is done while saving. The order in the body list is modified then. If you intend to refer to bodies in the application code, make sure the correct id is used (after saving).

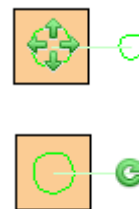


## Bodies



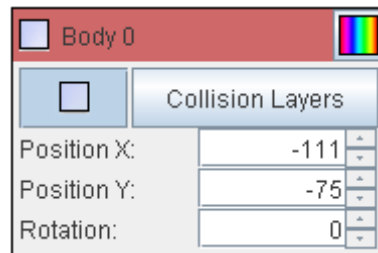
Bodies are added to the world area by clicking at the desired position. A body using the currently selected shape is created.

Bodies can be moved by dragging the circle at the center. By dragging the smaller circle the body can be rotated.



In the world panel the body detail view allows direct manipulation of the body position and rotation. The button on the top toggles the body state between static and dynamic.

The collision Layers button allows direct en- and disabling of each layer. For more details on this topic refer to the Engine documentation.



In the textfield below custom data can be entered. This data is retrieved when the world is loaded. It can be stored in a custom userdata class. See javadoc for further information.

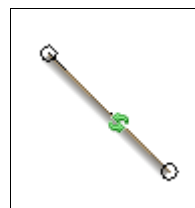
On each body various flags can be set: Can rotate determines whether the body can rotate, interacting determines whether the body collides with other bodies and affected by gravity can be used to avoid gravity effects for the body.

## Landscape



Landscapes are drawn by clicking for the first point of each segment and dragging the mouse to position the end point of the segment.

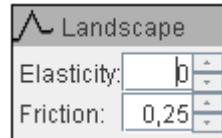
The end positions of the segments can be adjusted by dragging them. This option is only available in the select mode. This allows drawing the next



segment starting at the end of the previous in the landscape mode.

The facing direction of each landscape segment can be toggled by using the green button. For more information on this topic refer to the Engine documentation.

In the world panel the landscape detail view the physical properties of the complete landscape can be set.



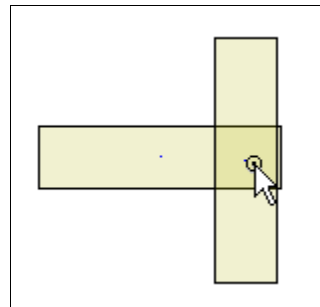
## Joints



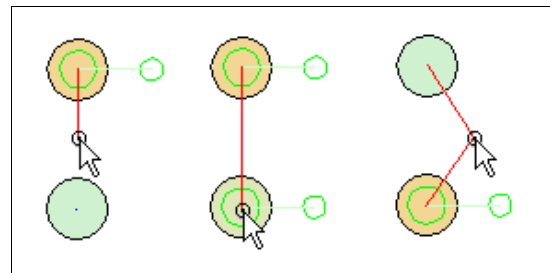
Both loose and fixed joints are added by clicking two overlapping bodies. This is the standard way of applying joints.

The collision bitflags are automatically set for both bodies such that they do not collide.

The joint position can be changed



To join two bodies at positions that are not overlapping the two bodies can be selected independently from each other. A third click is required to select the position of the joint.



## Springs

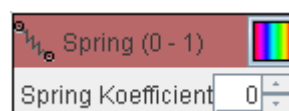
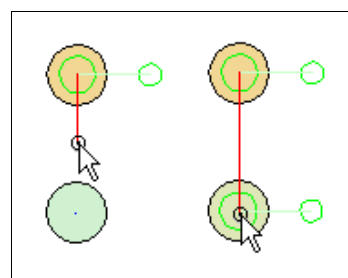


Springs are similar to joints. They are attached to two bodies. In each body there is an anchor position, which is selected.

The spring works along the connection of the anchor points.

The anchor points can be moved later on by dragging the indicating circles.

In the world panel the spring detail view is shown if the spring is selected. The spring coefficient determining its strength (0 indicates a completely stiff spring) can be set there. Refer to the Engine documentation for further information.

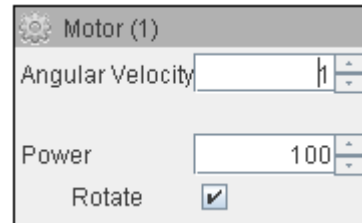
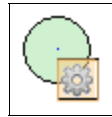


## Motors



Motors are applied to a single body by clicking on it. The motor is displayed as a cog close to the body center.

In the world panel the motor detail view can be set. The available parameters are the type of motor (translational, rotational), target velocity and maximum force.

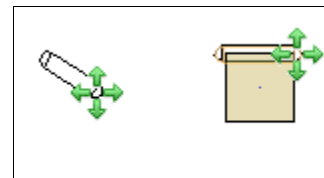
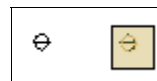


## Particles



To add a particle emitter to the world, simply click on the desired position. When the emitter is placed in an existing body, its position is fixed relative to that body.

The emitting area can be dragged to move and resize it.

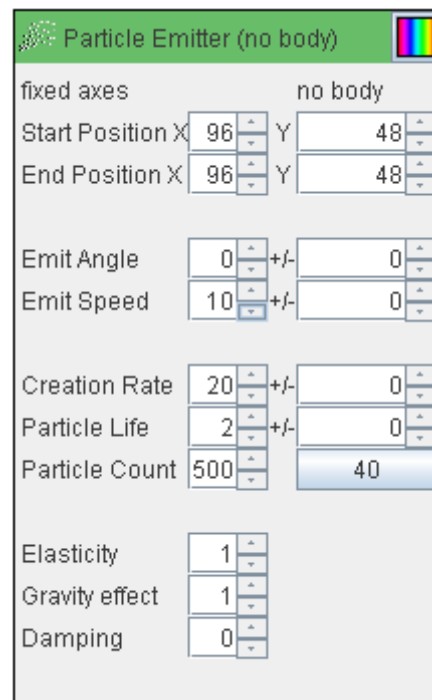


The following parameters can be set in the world panel:

- Emit position
- Emit angle and speed
- Emit ratio, life time
- Effect of Gravity, Elasticity, Damping

The values have deviation values next to it indicating the range of valid values.

The button next to the Maximum Particle count shows the optimal number of particle count. By pressing it the value is set. The optimum is the minimal value required to show all particles reliably. The actual number varies due to random variation effects. If the deviation is set to 0 for both the particle life and creation rate, the optimal maximum number is simply the multiplication of both.



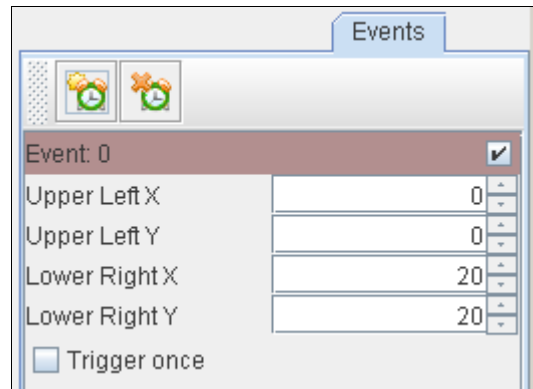
## Events

The event tab in the right side panel allows for event management.

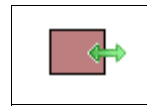
Events can be added to the world using the New Event button.

Events trigger whenever a body is inside the designated area. By checking the “trigger once” checkbox each event is triggered only once, when the condition holds for a body to avoid multiple calls in subsequent steps for a single event.

The checkbox in the upper right corner indicates whether the Event is displayed in the world area. The positions can be set directly in the form or dragged in the display area.



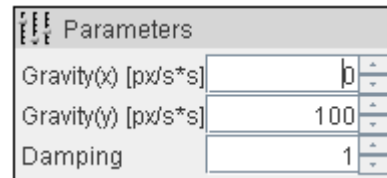
The screenshot shows the 'Events' tab in the right-hand panel. It contains a table for 'Event: 0' with a checked checkbox in the top right corner. The table has four rows for defining a rectangular area: 'Upper Left X' (0), 'Upper Left Y' (0), 'Lower Right X' (20), and 'Lower Right Y' (20). Each row has a small arrow icon on the right. Below the table is a checkbox labeled 'Trigger once' which is currently unchecked.



## Parameters

The simulation parameters can be adjusted in the World tab of the right side panel.

The gravity and damping factor can be set here.



The screenshot shows the 'Parameters' tab in the right-hand panel. It contains three rows for adjusting simulation parameters: 'Gravity(x) [px/s\*s]' (0), 'Gravity(y) [px/s\*s]' (100), and 'Damping' (1). Each row has a text input field and a small arrow icon on the right.

## Simulation

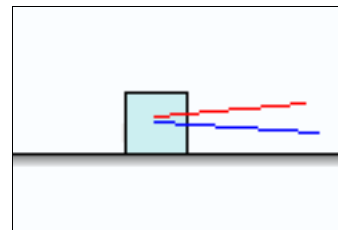


The simulation mode is started by either pressing Play or Single Step. The physical behavior of the world can be tested. For details pausing and performing single steps can be a great help. Stop changes back to the edit mode.

The blue line indicates the current velocity of the body.

Interaction in the simulation is realized by applying forces to bodies by dragging them. The red line shows the acting force.

The buttons at the bottom of the screen control how the simulation is displayed.



### Display messages



Toggles displaying of event messages. Each triggered event is listed by time.

### Display contacts



Toggles displaying of body contacts.

**Display AABB**

Toggles display of axis aligned boundary boxes

**Display Velocity**



Toggles displaying of body velocities.

**Display Vertex Velocity**



Toggles displaying of vertex velocities. Body rotation can be seen this way.