Physical Properties

2004-09-08

Mass, Density

In the Sandbox editor it is possible to specify either density or mass. If you specify one, set the other to a negative value (-1, or -0.01). Mass and density affect the way objects interact with other objects and float in the water (they sink if their density is more than that of the water).

Note that both values describe the same physical property. When you specify mass, density will be computed automatically and vice versa. The relationship mass = density x volume is used. These computations imply that the object is solid; if you use a box to model an empty crate, you should assume that its density is a weighted average between wood density and inside air density.

Here are some reference density values (in kg/m^3):

Common densities

Material	Density (kg/m^3)
Wood	500-700
Ice	900
Water	1000
Rubber	1500
Glass	2600
Iron	7500
Lead	11400
Gold	19300

max_time_step (0.005..0.1)

Sets the maximum time step the entity is allowed to make (defaults to 0.01). Smaller time steps increase stability (can be required for long and thin objects, for instance), but are more expensive.

Each time the physical world is requested to make a step, the objects that have their maxsteps smaller than the requested one slice the big step into smaller chunks and perform several substeps. If several objects are in contact, the smallest max_time_step is used;

damping (0..3)

Sets the strength of the damping on an object's movement. Most objects can work with 0 damping; if an object has trouble coming to rest, try values like 0.2-0.3. Values of 0.5 and higher appear visually as overdamping.

Note that when several objects are in contact, the highest damping is used for the entire group.

FixedDamping (true/false)

When true, this object will force its damping to the entire colliding group (use it when you don't want a particular object being slowed by a highly damped entity, like a dead body).

sleep_speed (0.01..0.3)

If the object's kinetic energy falls below some limit over several frames, the object is considered sleeping. This limit is proportional to the square of the sleep speed value. A sleep speed of 0.01 loosely corresponds to the object's center moving at a velocity of the order of 1 cm/s.

water_resistance (0..2000)

Water resistance coefficient. If non-0, precise water resistance is calculated. Otherwise only **water_damping** (proportional to the submerged volume) is used to uniformly damp the movement. The former is somewhat slower, but not prohibitively, so it is advised to always set the water resistance. Although water resistance is not too visible on a general object, setting it to a suitable value will prevent very light objects from jumping in the water, and water flow will affect things more realistically.

Note that water damping is used regardless of whether water resistance is 0, so it is better to set damping to 0 when resistance is turned on.

water_density (100..1000)

This parameter could be used to specify that the object's physical geometry can leak. For instance, ground vehicles usually have quite large geometry volumes, but they are not waterproof, thus Archimedean force acting on them will be less than *submerged_volume**1000 (with 1000 being the actual water density). Decreasing per-object effective water density will allow such objects to sink (as they would in reality) while still having large-volume physical geometry. Important note: if you are changing the default value (1000), it's highly recommended that you also change water_resistance in the same way (a rule of thumb might be to always keep them equal).

Addition: Dry static friction reference table

Material pair	**μ**
Aluminium/aluminium	1.9
Aluminium/steel	0.61
Brick/brick	0.65
Diamond/diamond	0.1
Glass/glass	0.94
Glass/metal	0.5-0.7
Gold/gold	2.5-4.0
Ice/ice	0.1
Rubber/concrete	1.0-4.0
Steel/steel	0.74
Wood/stone	0.4
Wood/wood	0.25-0.5
Stone/stone	0.4-0.7

