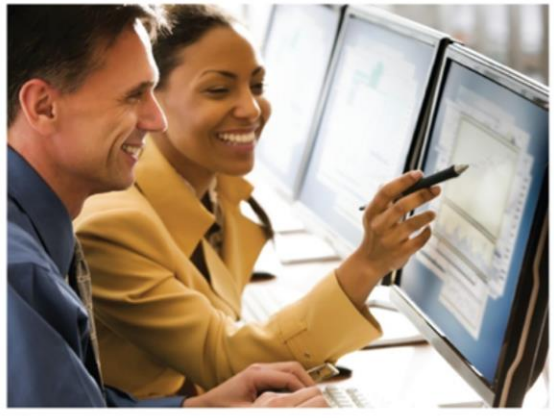
MathWorks | Training Services

Exercises: Introduction to Multibody Simulation

Physical Modeling for Formula Student



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Double Pendulum

Task: Model a double pendulum using simple solids.

Steps: Open the model `dblpend_start`. This model already contains the three basic blocks needed for any SimMechanics™ model.

1. **Define the links of the double pendulum.**
   Create two Brick solids, with dimensions and densities as shown in the diagram. Also, add frames to the links where they connect with the world or other links.

2. **Connect the links and the world using joints.**

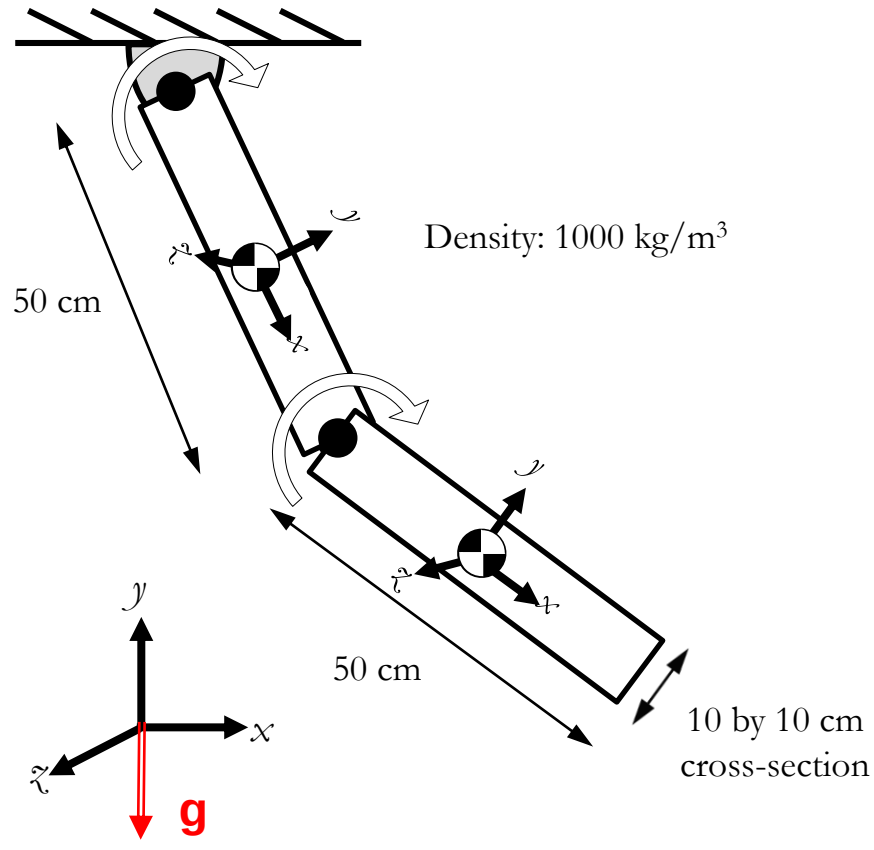
   Hint 1: The first link can revolve about an axis on the world frame.

   Hint 2: The second link can revolve about an axis on the first link.

3. **Change the direction of gravity.**
   Set gravity to act in the negative *y* direction, as shown in the figure.

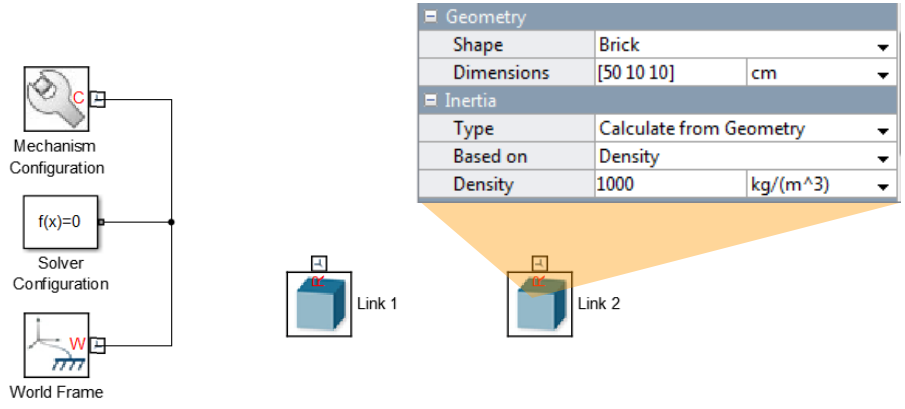
Try

```
>> dblpend_start
```

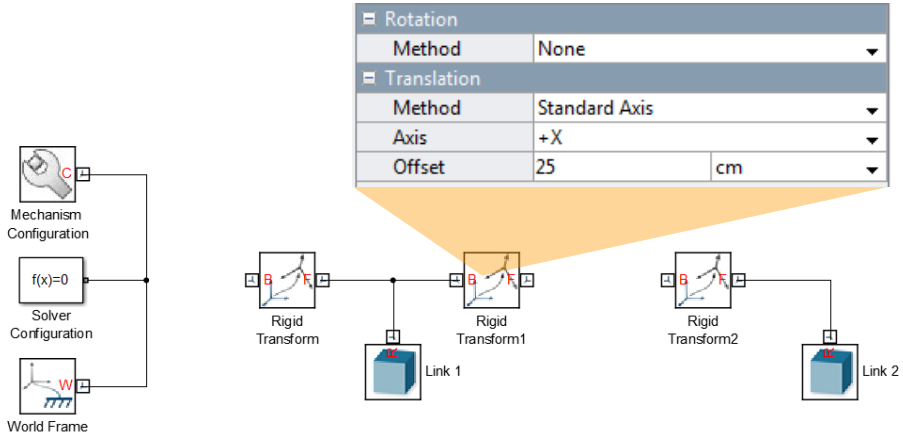


Solution: Double Pendulum

1. Open the model `dblpend_start`. Add two Solid blocks and set the parameters as shown.



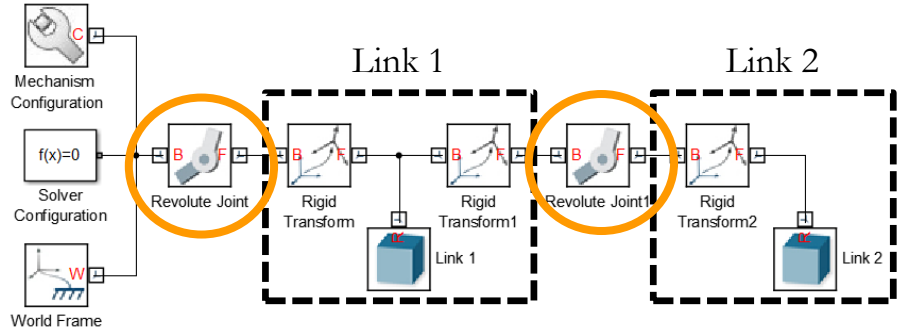
Then, add Rigid Transform blocks that create the frames for connecting the pendulum links.



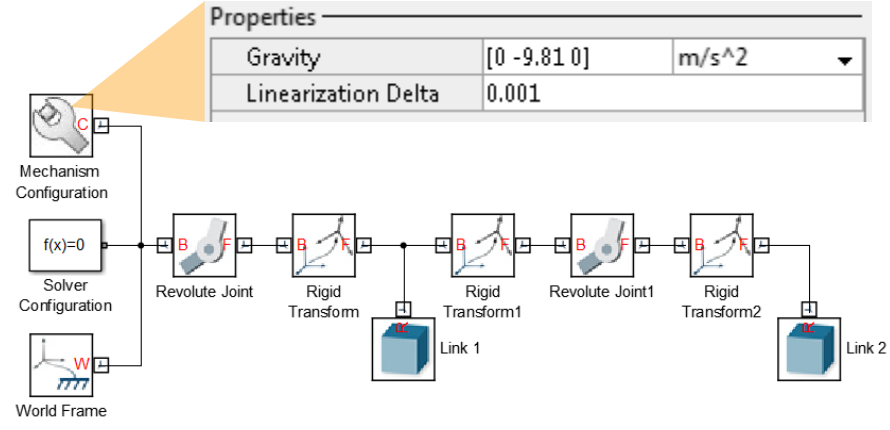
Try

```
>> dblpend_solution
```

2. Next, add Revolute Joint blocks that define rotational degrees of freedom.



3. Double-click the Mechanism Configuration block and change the direction of gravity to *-y*.



Pendulum on a Cart

Task: Model a pendulum on a cart using simple solids.

Steps: Open the model `pendcart_start`. This model already contains the three basic blocks needed for any SimMechanics model.

1. **Define the cart and pendulum.**
   Create two solids with dimensions and densities as shown in the diagram. The cart is a brick and the pendulum is a cylinder. Add coordinate frames to the bodies where they are to be connected.

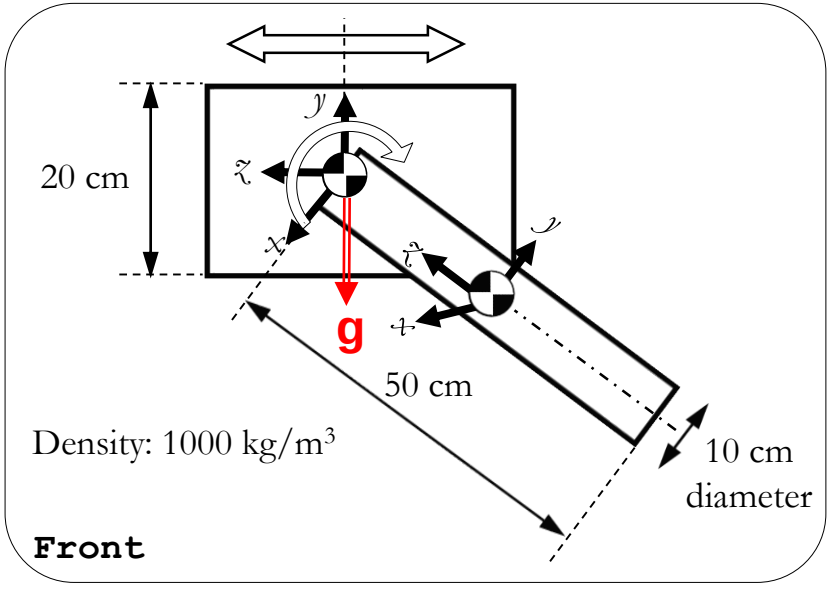
2. **Create the translational and rotational degrees of freedom.**
   Use a Prismatic Joint block so the cart can move along the z-axis of the World Frame. You do not need any transformations between the world and cart – assume that the origin of the cart is the world.

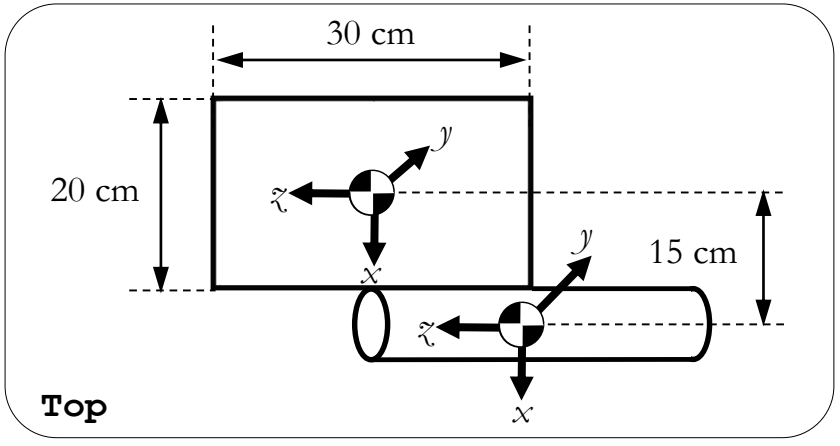
   Use a Revolute Joint block so the pendulum link is able to rotate about its attachment point to the cart. Ensure that the initial position of the pendulum is horizontal so there is motion in the simulation.

3. **Inspect the model with the Mechanics Explorer.**
   Select the Rigid Transform and Joint blocks while stepping through the animation. Observe how the base and follower coordinate frames move relative to each other.

Try

```
>> pendcart_start
```



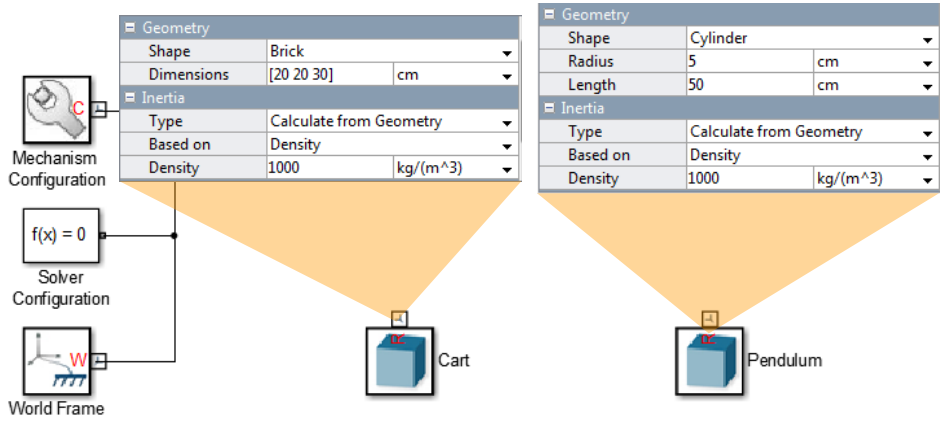


Solution: Pendulum on a Cart

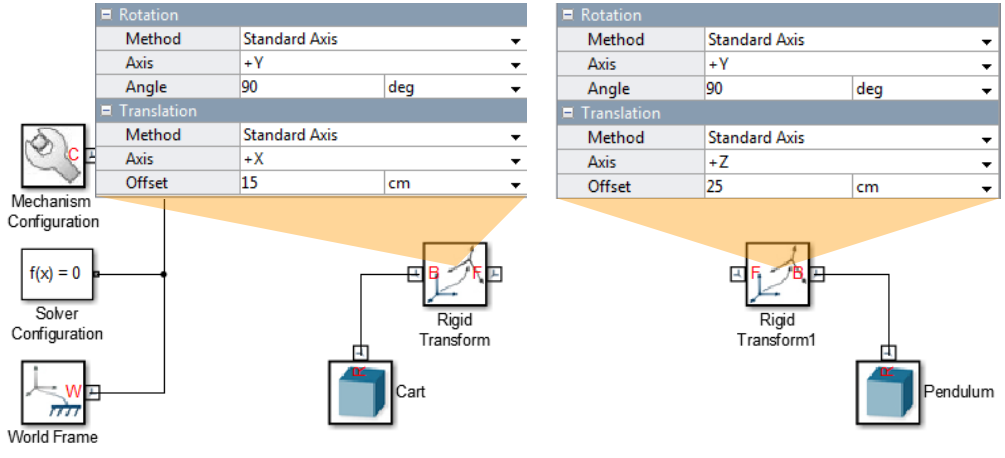
Try

```
>> pendcart_solution
```

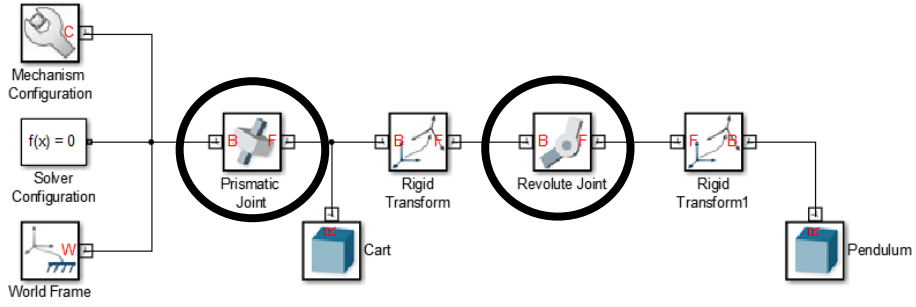
1. Open the model `pendcart_start`. Add two Solid blocks and set the parameters as shown.



2. Add Rigid Transform blocks that create the frames for connecting the bodies. Note the rotations necessary so that the z-axis of the Revolute Joint block is oriented correctly.



Next, add the Prismatic and Revolute Joint blocks to create the degrees of freedom.



3. View the Base and Follower frames of the Joint and Rigid Transform blocks using the Mechanics Explorer. Joint frames can translate and rotate relative to each other, but Rigid Transform frames always remain fixed with respect to each other.