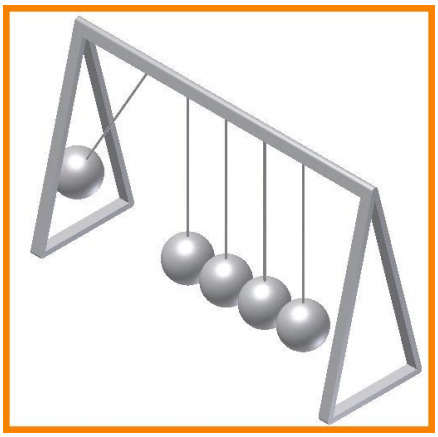
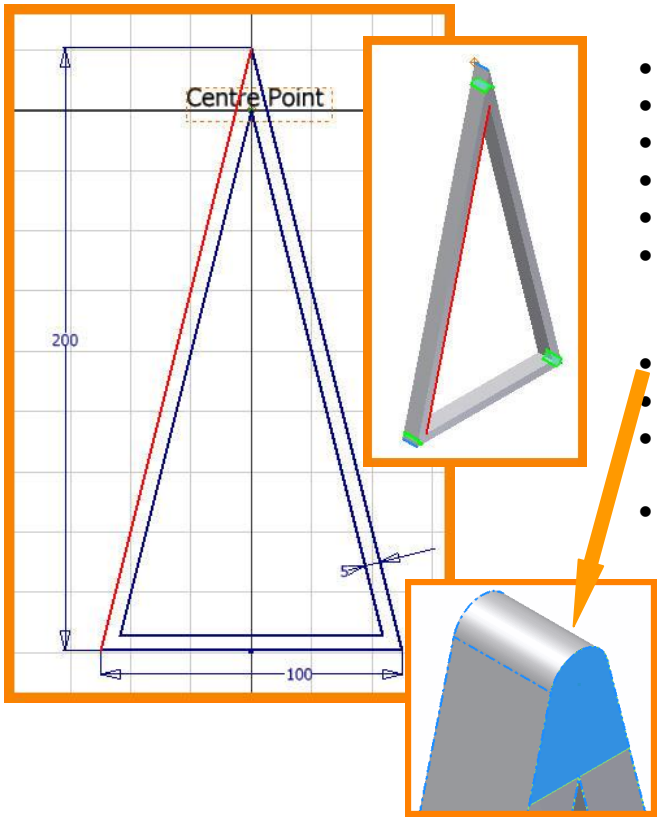
Simulation Tutorial 1 - Newton's Cradle

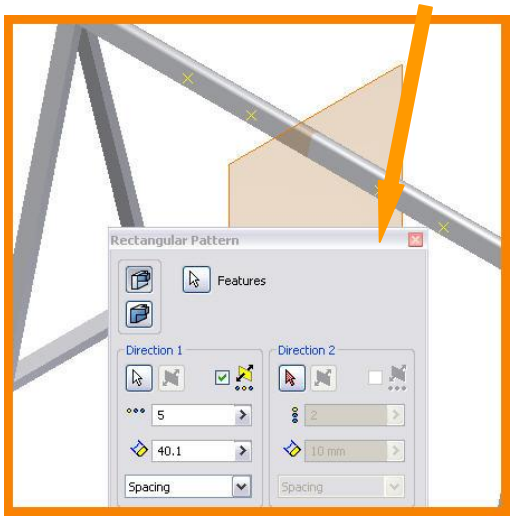


At first glance, the world of motion simulation can appear to be highly technical. You'll be pleasantly surprised during this first tutorial to learn just how easy it is to set up and use. It illustrates how you can take your CAD assemblies to the next level by being able to automatically convert assembly constraints to real life joints - all without leaving the familiar CAD environment

STEP 1 – Create Frame



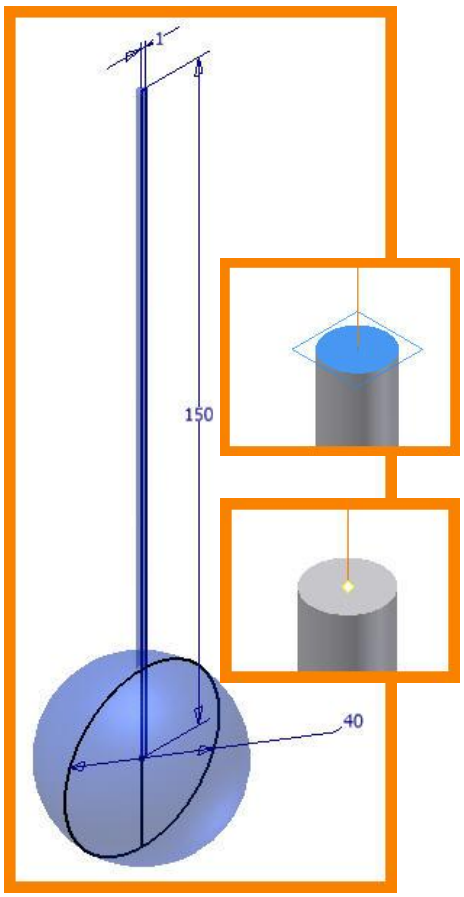
- Create new Part
- Create first Sketch on YZ Plane
- Create the left side of the frame as shown on left
- Extrude the profile by 10 mm
- Create 3 mm fillet on 3 outside edges
- Create the right side of the frame using rectangular pattern. Use 300 mm for spacing. Make sure you select fillets as well.
- Join both sides using extrude and shape on left below
- Create new work plane in middle of the frame
- Create work point in middle using new work plane and X-axis
- Create 4 more work points as illustrated below



- **Save part as Frame**

Note 40.1 will allow 0.1 mm clearance between Ø40 mm balls. Need clearance otherwise 2D Contact joint will not work.

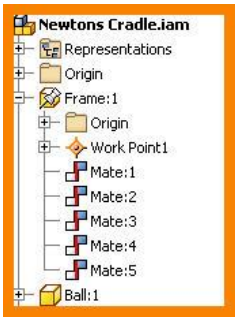
STEP 2 – Create balls

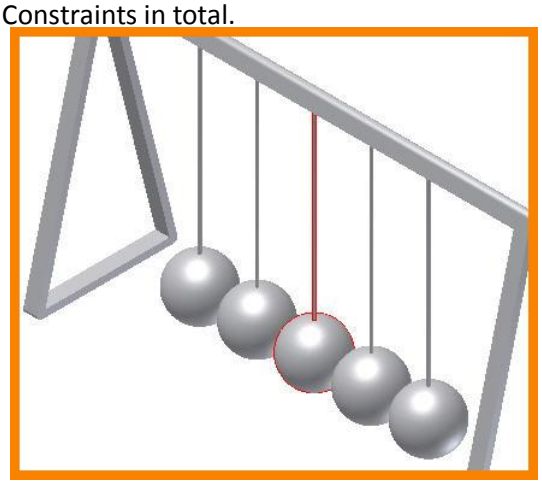


- Create a new part
- Create new sketch on XZ Plane
- Create ball and rod to the specified dimensions on the left
- Create workpoint using top face of rod and Z-axis
- **Save part as Ball**

STEP 3 – Create Newton's Cradle Assembly

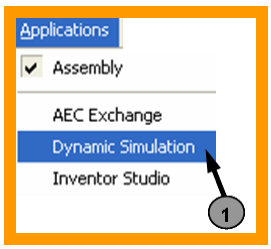
- Create new assembly
- Place the Frame and 5 instances of Ball component
- Constraint the Ball components and Frame component using workpoints only. Five Constraints in total.
- **Save Assembly as Newtons Cradle**



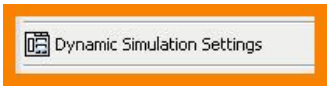


STEP 4 – Convert Assembly Constraints Automatically to Motion Joints

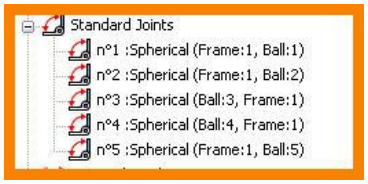
- Click Applications menu > Dynamic Simulation



- Make sure Automatically Update Translated Joints is ticked in the Dynamics Simulation Settings

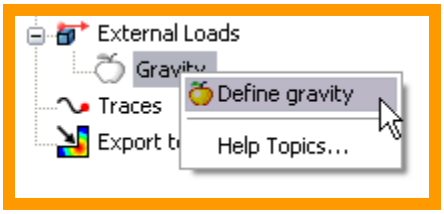


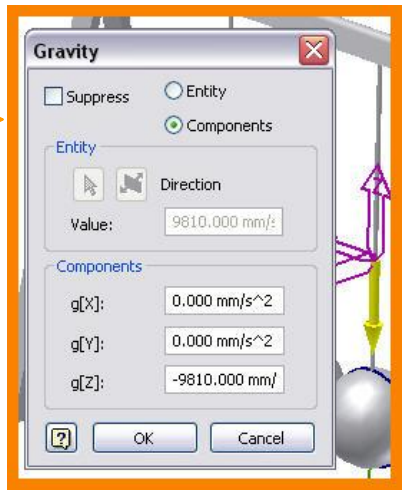
- You will notice that spherical joints will be created from point constraints. Five Joints in total



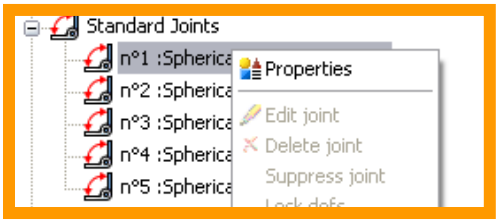
STEP 5 – Set Initial Conditions

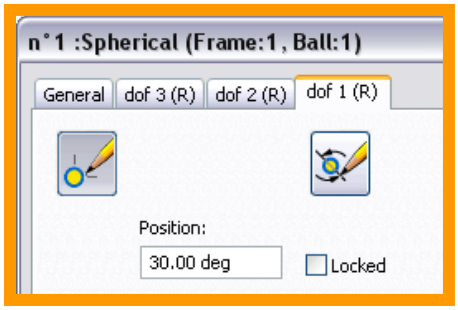
- Right click gravity to define gravity
- Set gravity to –Z direction

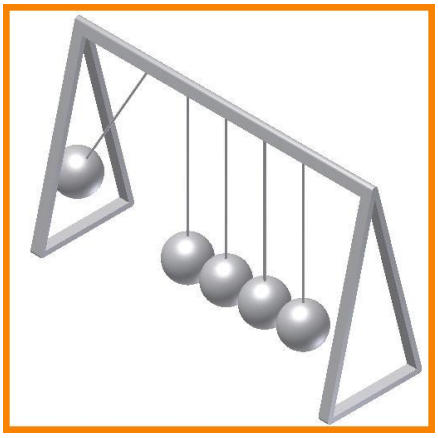




- Right click nº 1 joint. Select properties
- Select dof 1 (R) tab. Set position to 30 deg.

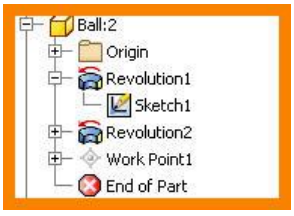




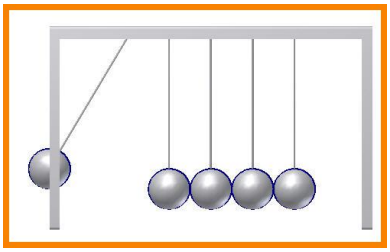


STEP 6 – Create Contact between balls

As the balls do not collide with one another we need to define contact between them. In order to use 2D contact we need to be able to select closed loops or edges on the ball. So before we can use the contact we need to define projected edges or sketches on the ball where the contact is going to occur.



- In the Dynamic Simulation graphic window Double Click on one of the ball components. This will activate the part environment.
- Make the Sketch1 visible(revolution feature for Ball)
- Switch of the dimension visibility



- Click on Return to exit Sketch Environment. As the Ball is an instance the sketch will appear on all balls as shown. We are now back in the simulation environment.

- Now click on Insert Joint from the Dynamic Simulation Panel
- Select 2D Contact from the pull down menu
- Now select edge of Ball:1 as shown below

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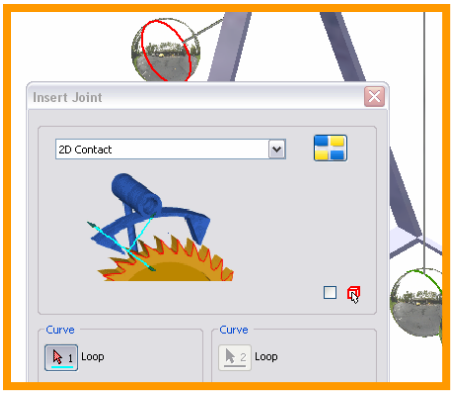
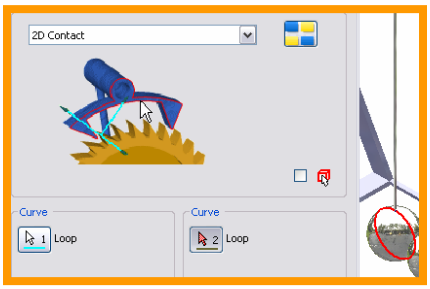
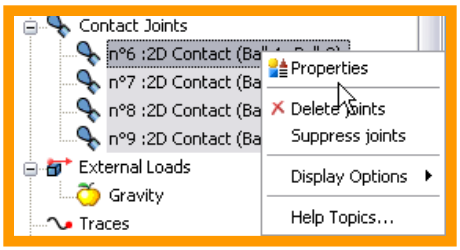


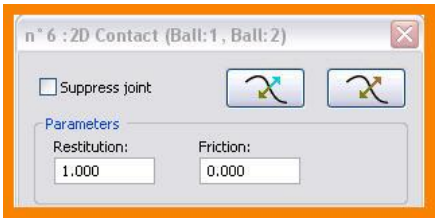
- To complete the 2D contact joint select loop 2 of the Ball:2 as shown. Click Apply



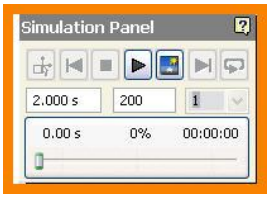
- Now create Contact between rest of the balls. There should be **4 contact joints** in total
- Next we need to alter the properties of the contact. To quickly alter all contact joints select the first joint and with the shift key pressed select the last joint. Right Click the first selected contact and Click properties as shown.



- Change restitution value to 1 and friction to 0



- Hide all sketches
- Set final time to 2 s in the Simulation Panel
- Run the simulation. See how the 3 middle balls do not move



Well done – Now try with seven balls with two balls moving together.