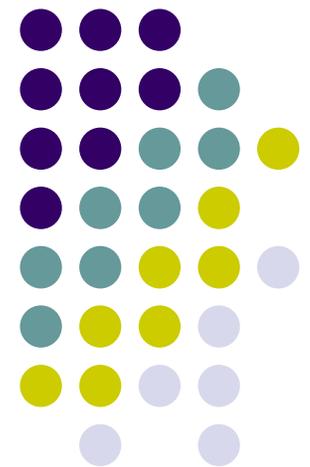


ADAMS Assignment 6

ME451: Kinematics and Dynamics of
Machine Systems



Turning in Your Assignment

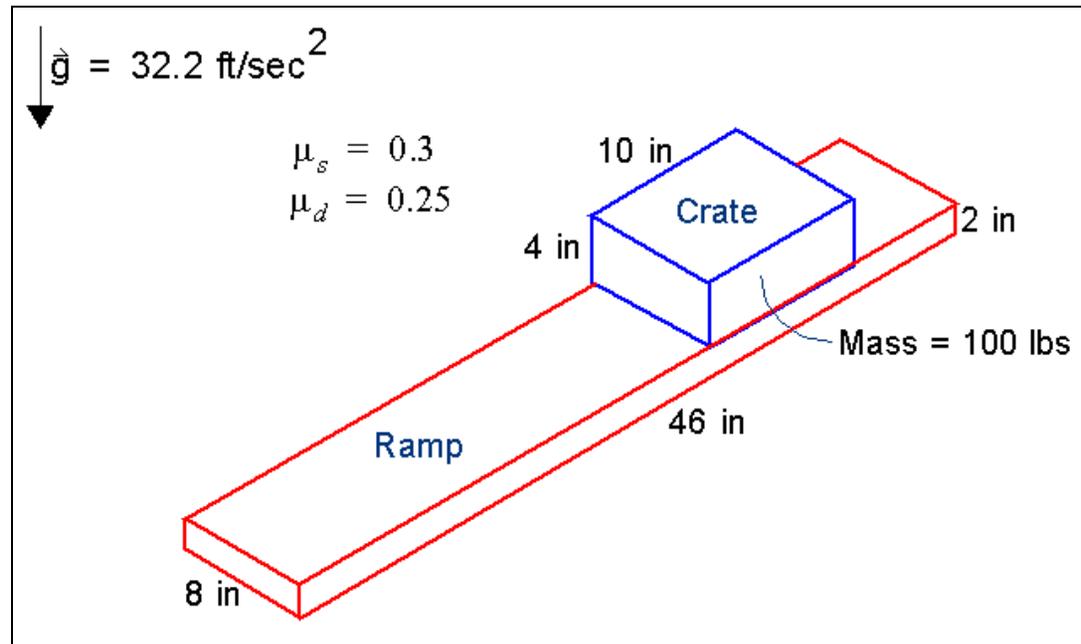


- Place all files in a directory called "lastName_ADAMS_06"
- zip that directory
- Drop the resulting file "lastName_ADAMS_06.zip" in the appropriate Dropbox Folder (ADAMS_06) at Learn@UW



Problem Statement

- Find the minimum inclination that will ensure that a crate slides off an inclined plane, using the properties shown next:



ADAMS Startup



- Start ADAMS/View:
 - Set the directory to your working directory
 - Create a new model named **inclined_plane**, with **Gravity** set to **Earth Normal (-Global Y)**, and **Units** set to **IPS - inch, lbm, lbf, s, deg.**

Change working grid orientation



- Adjust the working grid
 - Now adjust the spacing and orientation of the working grid.
- To adjust the spacing and orientation of the working grid:
 1. From the **Settings** menu, select **Working Grid**.
 2. Set **Spacing** to **1 in** in the **x** and **y** direction.
 3. Make sure that the working grid is oriented along the global XY direction (default setting when you open ADAMS/View).



Build the parts

- Build the parts
 - When creating parts, use an inclination angle of 0° . You will rotate the parts to the desired inclination angle later in the exercise. Be sure to set the ramp geometry to be on ground.
- To build the parts:
 1. Build the ramp geometry using the following parameters:
 - ◆ **On Ground**
 - ◆ **Length: 46 in**
 - ◆ **Height: 2 in**
 - ◆ **Depth: 8 in**
 2. Build the crate geometry using the following parameters:
 - ◆ **New Part**
 - ◆ **Length: 10 in**
 - ◆ **Height: 4 in**
 - ◆ **Depth: 8 in**
 3. Locate the create near the right end of the ramp

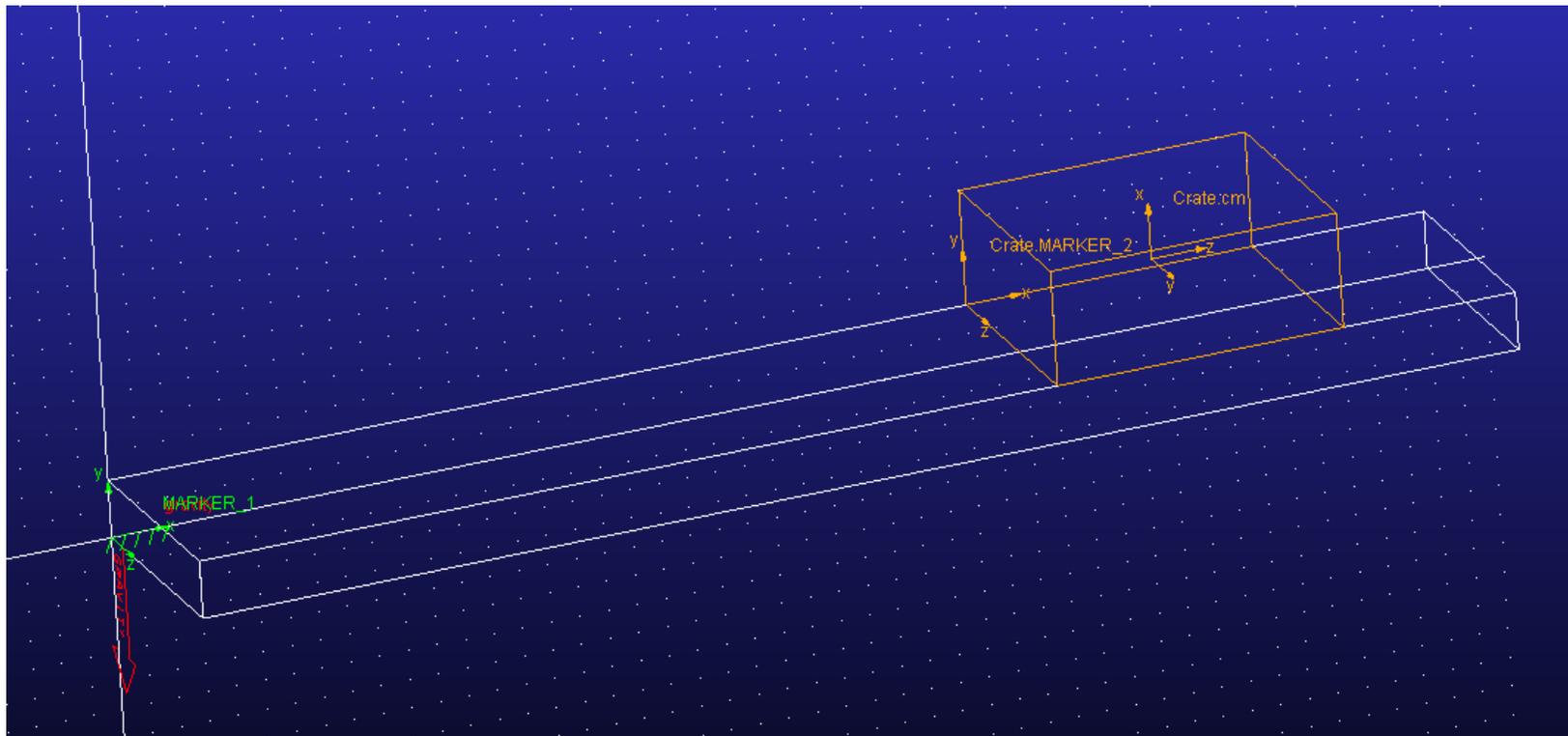
Part Mass



- To modify the parts:
 1. Rename the crate and the ramp geometry as shown in the figure on slide 3.

Note: Make sure that you rename just the geometry and not the ground part.

 - ◆ Right-click on the large box, point to **Block: BOX_1**, and then select **Rename**.
 - ◆ Enter **Ramp**.
 - ◆ Select **OK**.
 - ◆ Repeat this step for **PART_2**, naming it **Crate**.
 2. Set the **Mass** of the crate to **100 lbm**:
 - ◆ Right-click the crate, point to **Part:Crate**, and then select **Modify**.
 - ◆ Set **Define Mass by** to **User Input**.
 - ◆ In the **Mass** text box, enter **100 lbm**.
 - ◆ Select **OK**.



Inclination



- **Set the model's inclination angle**
 - Now you are going to rotate the model 15° . Because the ramp is on ground and you cannot rotate ground, to rotate the ramp, you are going to change the orientation of the ramp's corner marker to 15, 0, 0. The orientation of this marker sets the orientation for the ramp. You'll use the **Rotate** tool to rotate the crate since it is not on ground. You'll rotate the crate about the same axis that you rotated the ramp about.

Rotate ramp

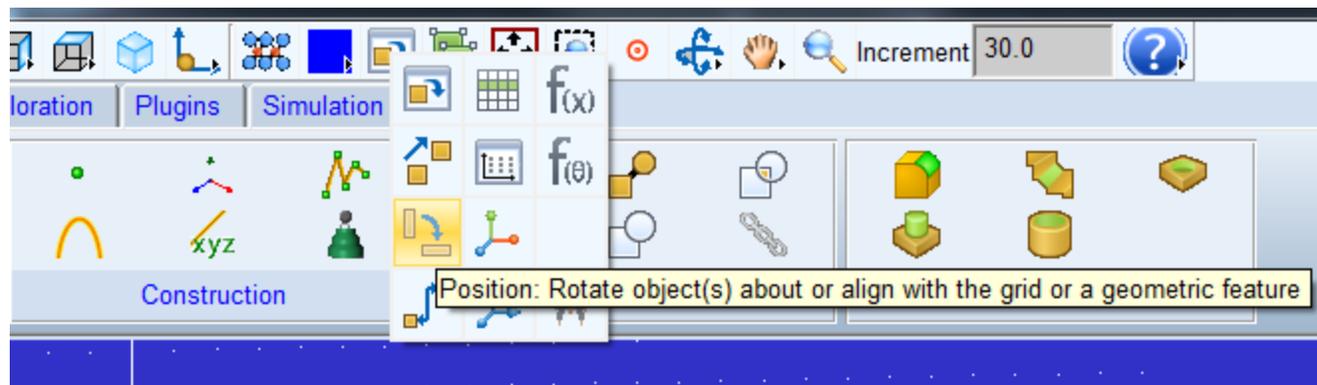


- To rotate the ramp to $\theta = 15^\circ$:
 1. Right-click the ramp's corner marker, point to **MARKER_1**, and then select **Modify**.
 2. In the **Orientation** text box, change 0,0,0 to **15,0,0**.

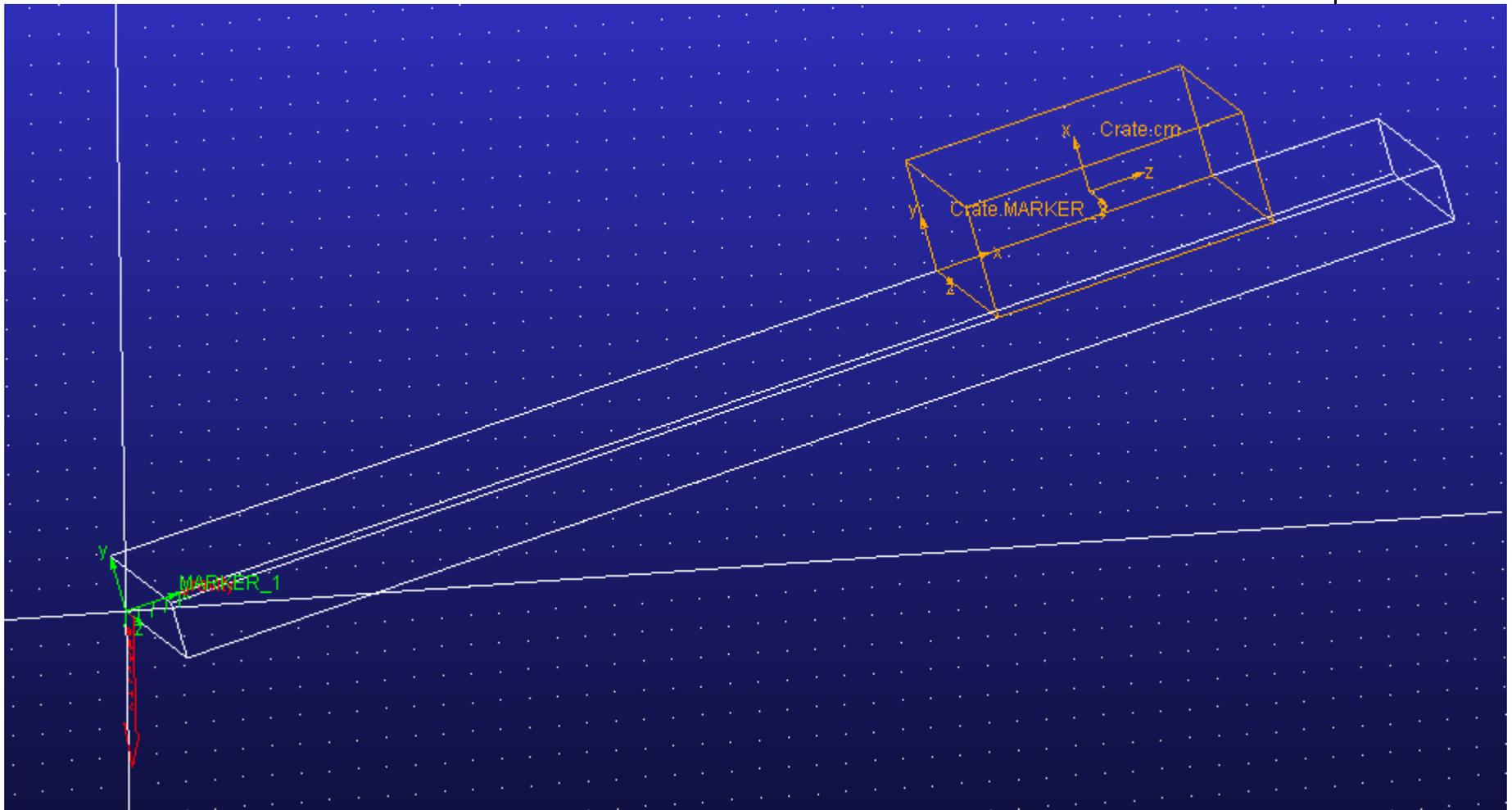


Rotate crate

- To rotate the crate 15°:
 1. On the top-most ribbon (to the right of “Tools”), right-click the Position icon, and select the **Position: Rotate...** tool



2. In the container, in the **Angle** text box, enter **15** as the increment by which to rotate the crate. After you enter this value, if your cursor does not sweep the text box (that is, move from inside the text box to outside the text box), press Enter to ensure that the text box registered the value you entered.
3. Select the crate as the object to rotate.
4. Choose the z-axis of MARKER_1 as the axis to rotate about



Constraints



- **Constrain the model**
 - Now you'll create a translational joint between the ramp and the crate.
- **To constrain the model:**
 - From the **Connectors** tab, select the **Translational Joint** tool 
 - ◆ Use the options **2 Bod-1 Loc** and **Pick Feature**.
 - ◆ Set the location of the translational joint at the crate geometry's base marker, **MARKER_2**.
 - ◆ Set the vector so it points up the ramp: select the x-axis of **MARKER_2**.

Measures



- **Take measurements**

To create a measure:

- Create an object (part) measure for the crate's acceleration along the ramp :
 - ◆ **Characteristic: CM acceleration**
 - ◆ **Component: X**
 - ◆ **Represent coordinates in: MARKER_1** (for the location of the corner marker, see Figure on slide 10).

Add friction forces



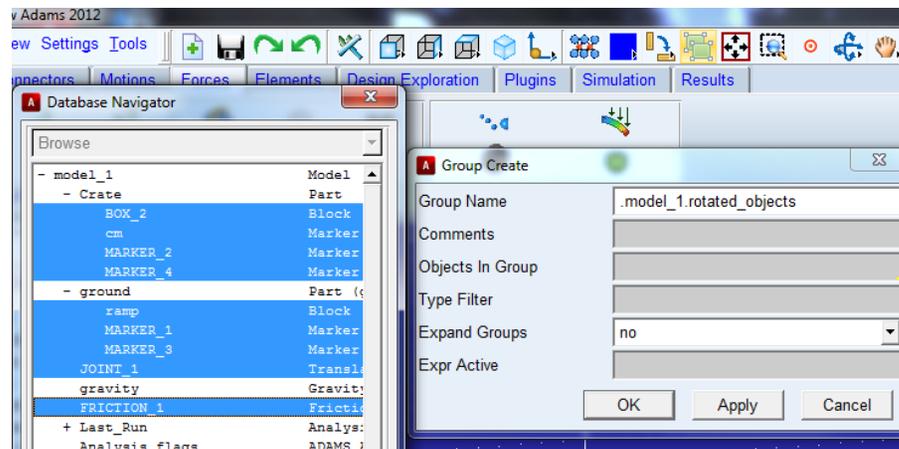
- Refine the model
 - In this section, you'll add joint friction to the translational joint using the μ_s , μ_d values from the problem statement. You'll then simulate the model to see if the crate slides off the ramp.

Tip: Be sure that the only friction forces to consider are those resulting from reaction forces.
- To add friction and simulate:
 1. Display the joint's modify dialog box (right-click the translational joint, point to **Joint:JOINT_1**, and then select **Modify**).
 2. In the lower right corner of the Modify dialog box, select the **Friction** tool  μN
 3. Fill in the coefficients of friction provided on slide 3.
 4. Leave the remaining friction parameters at their default values.
 5. In the **Input Forces to Friction** section, clear the selection of **Bending Moment** and **Torsional Moment**.
 6. Simulate the model and note if the crate slides off the ramp.



Change inclination angle

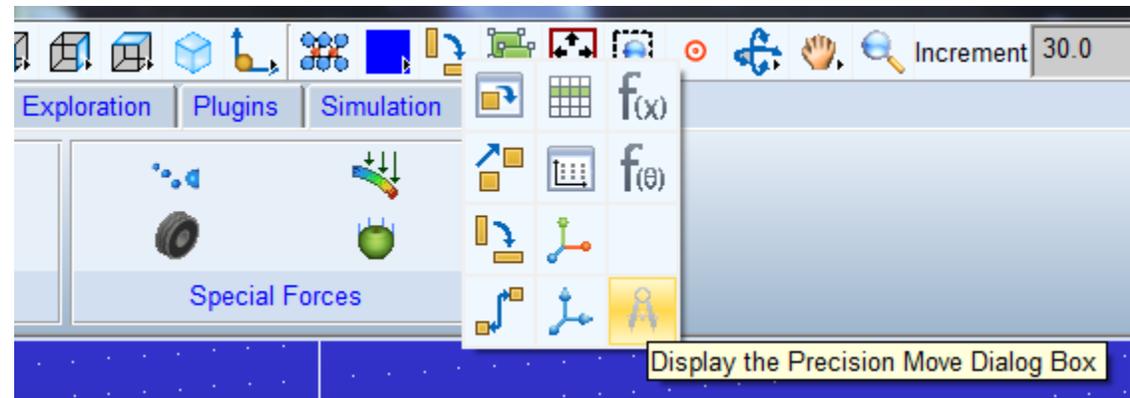
- Rotate the ramp and crate to $\theta = 20^\circ$
 - To rotate the ramp and crate, you'll create a group consisting of the crate part, joints, and geometry making up the ramp. You'll then select that group and rotate it.
- To create a group:
 1. On the top ribbon, select **Group**.
 2. Make a group, named **rotated_objects**, containing:
 - ◆ The crate part.
 - ◆ The joint.
 - ◆ All of the geometry (including markers) on the ramp, but not the ground part itself, because, remember, you cannot rotate ground.
 - ◆ **Note: to easily select all the items you want, right-click "Objects in group", select "All→Browse", then hold the Ctrl button to select all the items to group**





Rotate the group

- To rotate the group:
 1. From the topmost ribbon, right-click the select the **Precision Move** tool
 2. Set **Relocate the to group**.
 3. In the text box to the right of **Relocate the**, enter the group name, **rotated_objects**.
 4. Set the menus in the second row to **About the** and **marker**.
 5. In the text box to the right of these menus, enter **MARKER_1**.
The Precision Move tool rotates objects in increments about a specified axis of the marker you just selected.
 6. In the  text box, enter **5**.

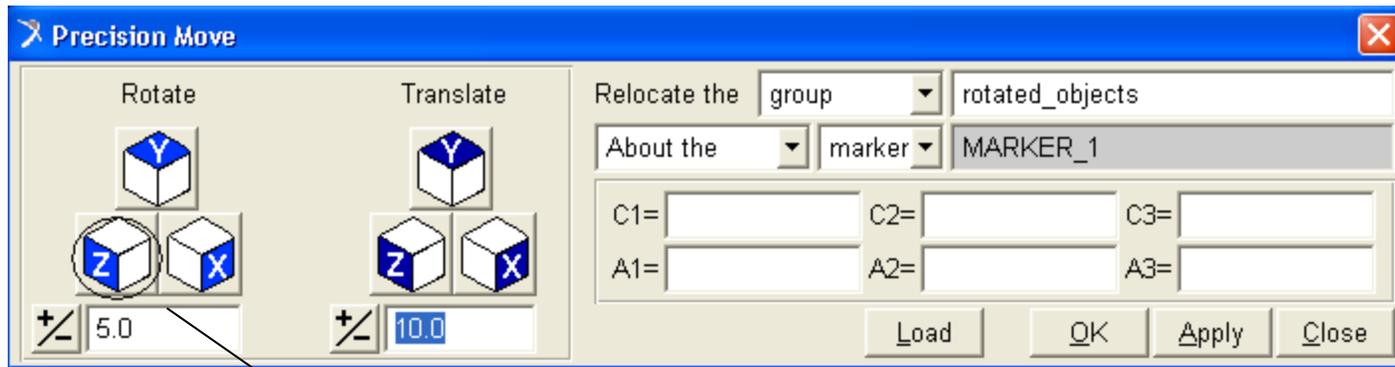




Precision Move

7. Select the **Z**-axis box. Note that you can select the axis box (either X, Y, or Z) to rotate a group to the desired orientation.

The following shows the Precision Move dialog box after you've completed this procedure.



Because you have already rotated the ramp to 15 degrees, and now you want to rotate it to 20, enter 5 as the angle

8. Do **not** select **OK** or **Apply**, just select **Close**.

Determine maximum no-slip angle



- **Find inclination angles**

To find the inclination angles between which the crate starts to slide:

1. Simulate the model and note if the crate slides off the ramp.

For an end time of 0.5 seconds, verify that the crate acceleration versus time stripchart matches the adjoining figure.

The initial spike is due to the acceleration (due to gravity) present at $t=0$.

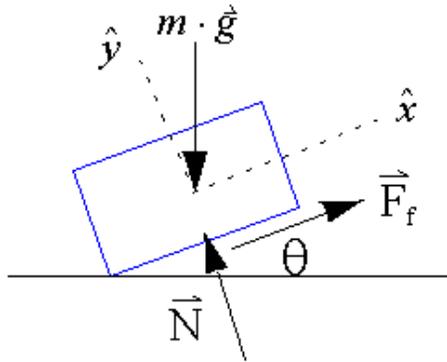
2. Through trial and error, find the approximate angle (within 0.5°) at which the crate starts to slide off the ramp.



Questions

1. What is the approximate angle (within 0.5°) at which the crate starts to slide off the ramp?
2. Plot crate acceleration versus time at $\theta = 15^\circ$ and $\theta = 20^\circ$

Analytical Part:



1. Find the acceleration of the crate in x direction at $\theta = 15^\circ$ assuming no friction.
2. Find the Maximum angle at which the crate will not slide. Show all the calculations.
3. Compare this angle with the approximate angle (within 0.5°) you got from ADAMS.

References:

- MSC.Software Corporation, ADM 701, Workshop 7, Jan. 2005

