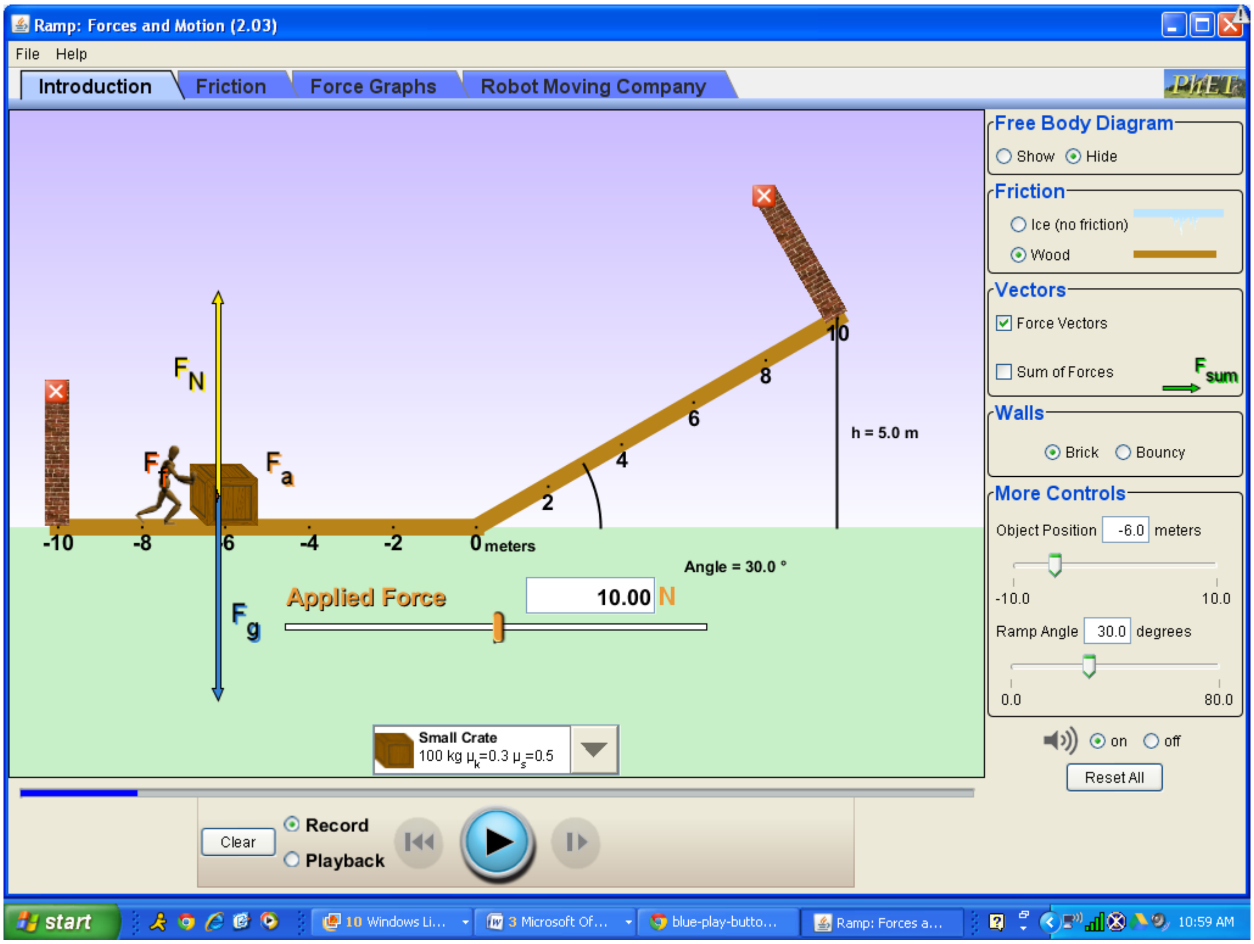
Forces and Friction

Lab Procedure – Answer the questions in red.

Download and run the Java application “ramp-forces-and-motion_en.jar”. The Introduction screen will look like the screen capture below.



1. On the “Introduction” screen, you will be starting with a crate that has a mass of 100 kg and a coefficient of sliding friction of 0.3 and a coefficient of static friction of 0.5

   Draw the Free Body Diagram (a picture showing the forces on the crate) before you apply any force. You do not need to turn the diagram in, just describe below. The crate should be stationary at -6.0m on the horizontal axis.

a) Describe the vector forces in your free body diagram.

Make sure that the application is initially “paused”. Also, check the “record” button. If it is not paused, press the pause button, the clear button. Add 100N of applied force, and push the  button and record what happens.

b) Draw a free body diagram showing all the forces. Describe all of the vector forces on your diagram.

2. Calculate how much force would be required to get the crate moving from rest.

a) Explain how you calculated this, and give your result.

Now try it out by entering the force you calculated (or a tiny bit more, say 5%), and pressing the play button. Make sure you are paused with a clear screen first.

b) What happened?

c) What happened as the crate began to move up the ramp? Describe a free body diagram while the crate is on the ramp. What force is working against your applied force?

d) Calculate the MINIMUM force you will need to apply to get the crate up to the top of the ramp. Explain how you did the calculation and give your prediction.

3. Select the "Friction" tab on the app. Reset and clear all. Make sure you are paused. The applied force should be set at zero. You can use the box on the right labeled "More Controls" to set the initial position of the crate at +8m, up near the top of the ramp. If the system is paused (play/pause button is showing forward arrow), the crate will remain in place. Use the slider bar to set the coefficient of kinetic friction to 1.0.

   a) Draw a free body diagram for the crate. Explain the vectors in your diagram.

   b) Press the play button. What happened? Why?

   c) Calculate the highest coefficient of static friction the will allow the crate to begin sliding down the ramp when it is released. Explain your calculation and the result you obtained.

d) Try out your prediction from (c) by using the application. What is your result?

3. With everything paused and cleared, place the block near the top of the 30º ramp (Position = 8.0 m). Set the coefficient of static friction back to 0.5. What is the net force on the block down the ramp? (you can use your free body diagram from 3 (a) above).

   a) What is the acceleration of the block down the ramp? Describe how you did your calculation.

   b) What would be the final velocity of the block at the bottom of the ramp?

c) What force is acting on the crate once it hits the flat part at the bottom of the ramp? What is the magnitude and direction of that force?

d) What will be the acceleration of the crate on the flat part at the bottom of the ramp?

e) Calculate how far the crate should slide at the bottom. Explain how you did your calculation, including equations used.

f) Try it out. How did your calculation compare to the applet result?