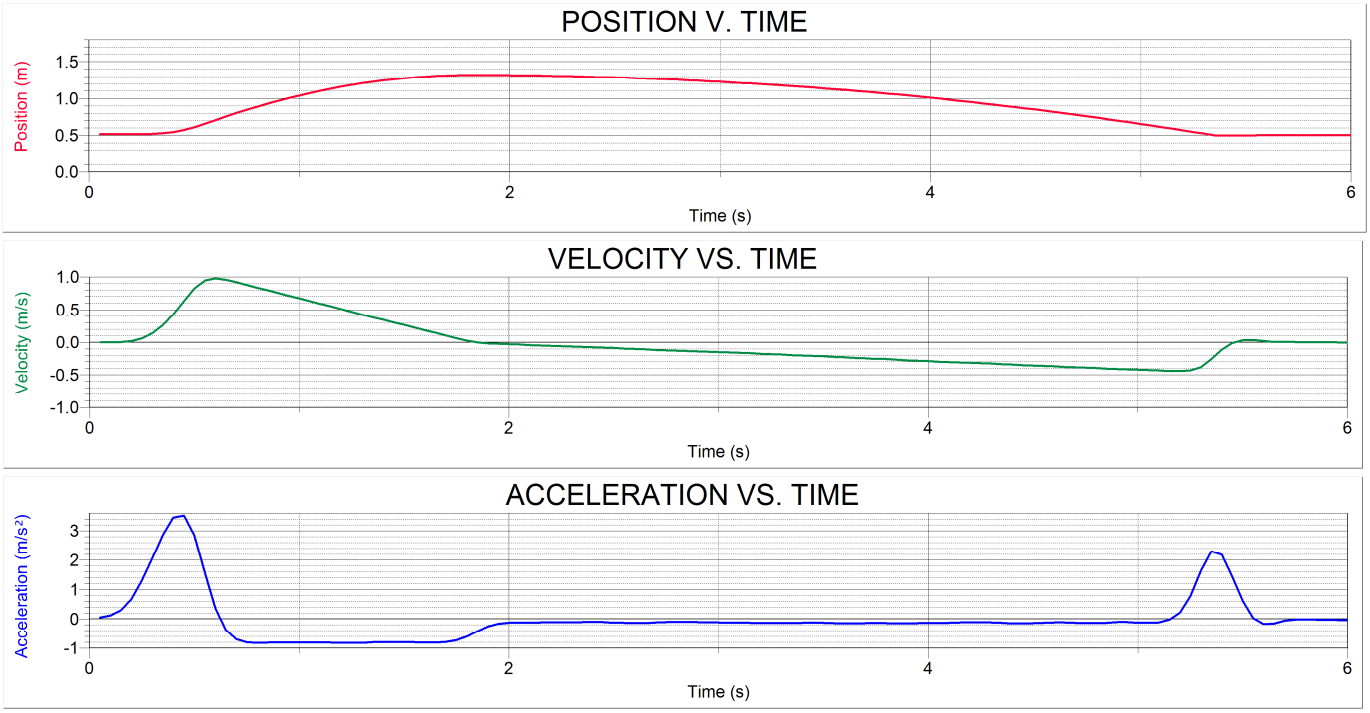
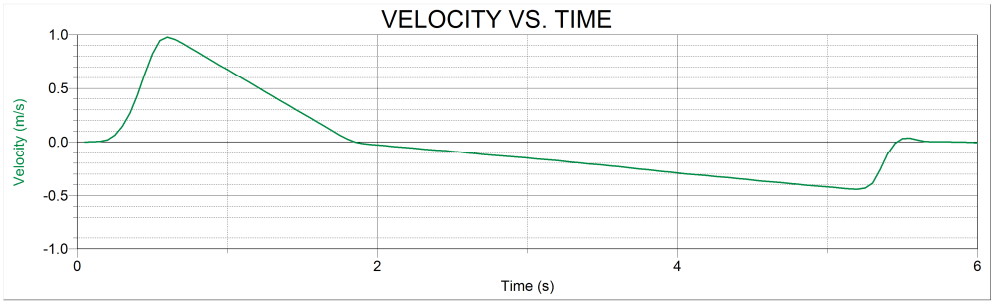
Lecture 12 – Energy ILD – Demonstration 5

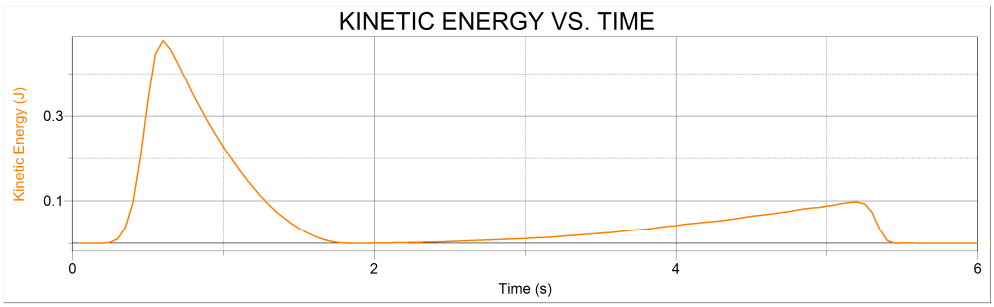
In the afternoon lecture we did not properly discuss the last demonstration due to time. The graphs below show the actual data taken in that demonstration at the very end of the lecture.

Remember that the cart was given a push up the inclined ramp (positive direction up the ramp) away from the motion detector, as in the previous demonstrations. It reached a maximum distance from the motion detector, and then rolled back down to the position from which it was released, where it was caught again. The difference between this demonstration and the previous ones was that the cart had a friction pad on the bottom, whereas in the previous demonstrations it was assumed that friction was negligible.

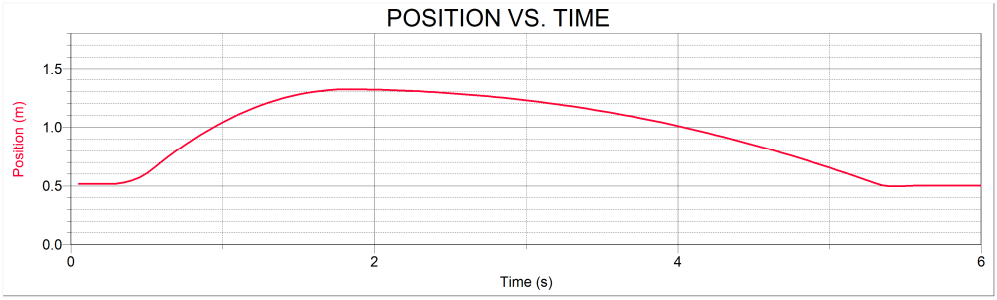


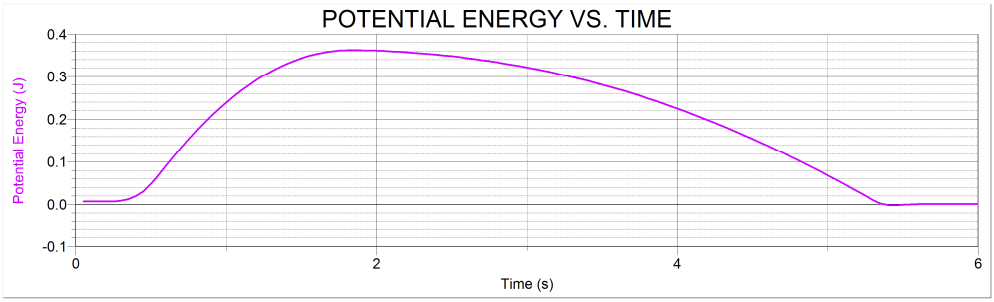
Note that the friction force always acts in a direction opposed to the motion. This means that on the way up, both the component of the gravitational force along the ramp and the friction force act in the same direction. This gives a large (negative, down the ramp) acceleration. As the cart rolls down again, the frictional force is now in the opposite direction to the component of the gravitational force along the ramp, and the net force and hence acceleration (negative, down the ramp) is less in magnitude than when the cart is travelling up the ramp. In fact, looking at the bottom graph above, the magnitude of the acceleration is nearly zero. Note that, as we would then expect, the cart takes a longer time to come down again than it took to go up.





The kinetic energy graph, compared to the case when there is no friction, is no longer symmetric about the point in time at which the cart reaches its highest point on the ramp. The shape of the kinetic energy peak on the catch at the bottom is different to that on the push at the start. The peak is much less in magnitude, since the speed of the cart just as it is about to be caught is less than the speed just after it is pushed and released. Remember that the kinetic energy is proportional to the square of the speed.





The potential energy graph versus time still follows the same shape as the position versus time graph, only now, in each case, the shape of the parabola before the cart reaches the highest point on the ramp is different to the shape after it has reached the highest point. The parabola is not as steep on the way down since the cart is taken longer to come down than go up.

The total mechanical energy graph versus time again is just the sum of the kinetic and potential energy graphs. In this case, however, total mechanical energy is not conserved during the period of time between the push and the catch, since friction is doing work on the cart/ramp system to transfer energy out of it.