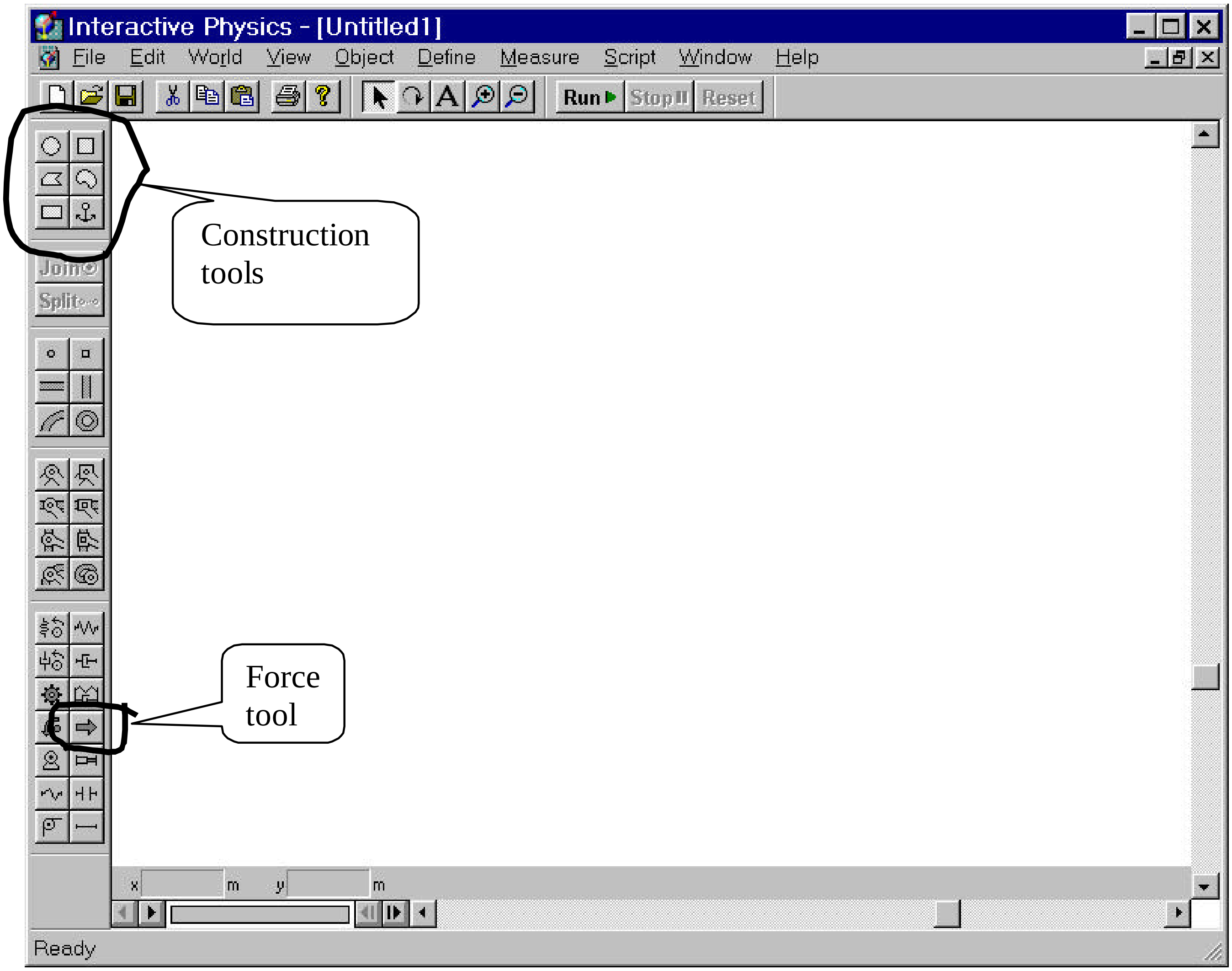
Using Interactive Physics

Interactive Physics is a program that is useful for simulating various physical situations. Initially we will be using it for simulating simple mechanical systems. However, it is also able to simulate very complicated mechanical systems using joints and constraints. At this time, you need to familiarize yourself with Interactive Physics.

Start Interactive Physics by double clicking on its icon on the desktop. You should see a window that looks similar to the one shown below.

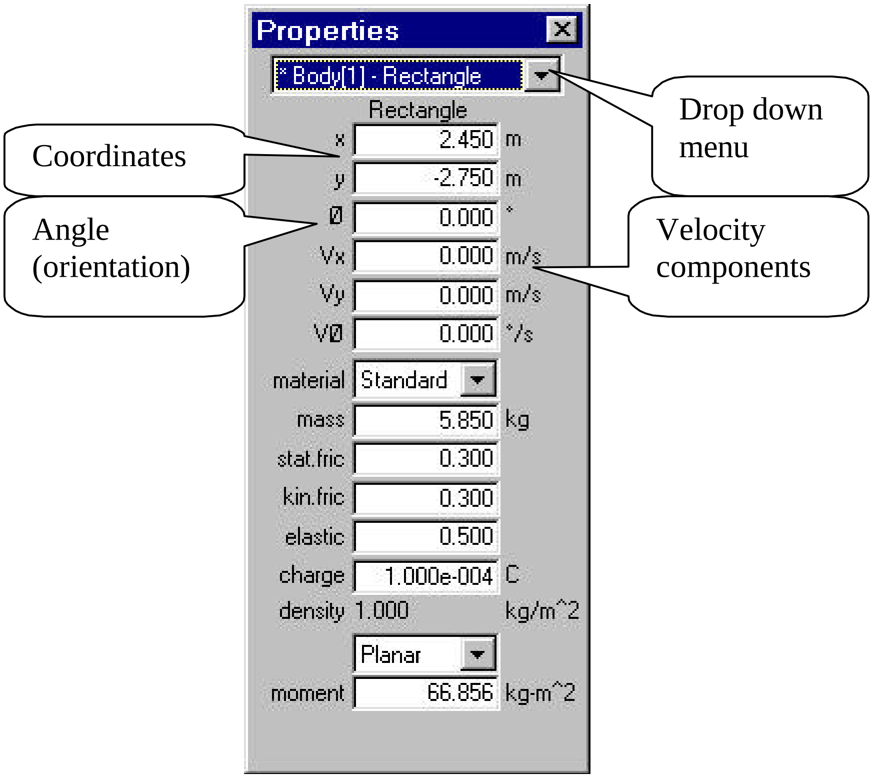


On the left hand side of the screen are your construction tools. You have other items that you can change listed in the menu to the left of the white region. As with any piece of software, it is often best to simply learn how to use it by playing with it. You should familiarize yourself with the drawing tools circled on the left hand side.

Draw a rectangle that extends across the entire screen by selecting the rectangle tool and left-clicking and dragging. See what happens to the rectangle in the simulation by clicking on the **Run** button at the top of the screen – this starts the simulation. Stop the simulation by either left-clicking the mouse or clicking on the **Stop** button. Reset the simulation to the beginning by clicking the **Reset** button.

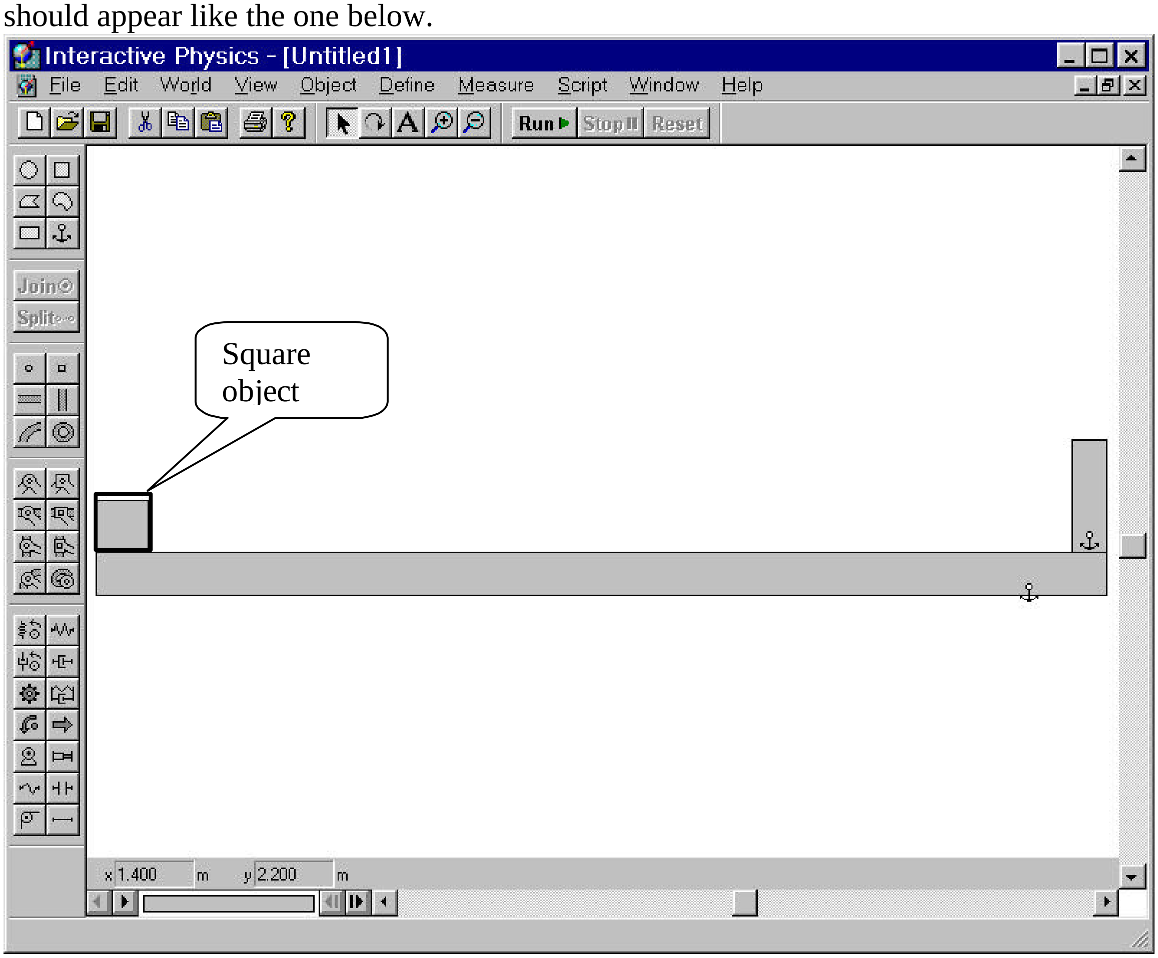
To hold an object in place, use the anchor tool. Click on the anchor icon in the construction tools and then click on the object you want to hold in place. Now, try the simulation.

We can change the properties of any object by double clicking on the object and bringing up the properties box for that object. We can change objects by using the drop down menu on the properties box. Also listed are the coordinates of the center of the object, the objects orientation (angle with respect to the x-axis) and velocity components. You can change the material properties by selecting from the pre-defined materials (standard, steel, ice, wood, plastic, clay, rubber and rock). You can also define your own material by just changing the values of the mass, coefficient of static friction, coefficient of kinetic friction, and coefficient of elasticity.



For this assignment, set the coefficients of static and kinetic friction to zero, also set the coefficient of elasticity to zero.

Add a second rectangle at the right end of your horizontal rectangle and anchor this one. Set the properties such that it has zero coefficients of friction and elasticity also. Now add a square object so that it is sitting on the top of the rectangle on its left hand edge. Set this object's properties to have zero coefficients of friction and elasticity. Also, change the mass of the square object to 1 kg. Your IP screen should appear like the one below.

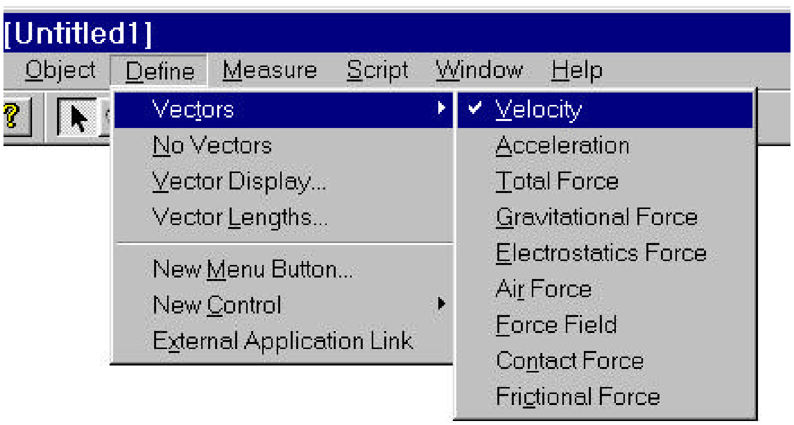


What you are going to do is give the object an initial velocity to the right, and acceleration directed either to the left or the right.

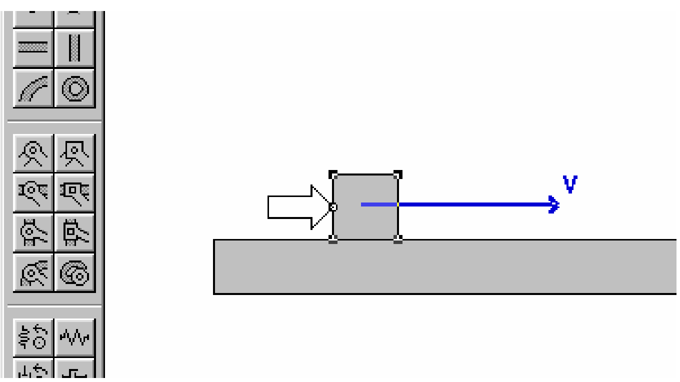
1) If the acceleration is in the same direction as the velocity, describe the motion (this means to describe what happens to both the velocity and position measurements).

2) If the acceleration is in the opposite direction of the velocity, describe the motion.

To give the square object an initial velocity, double click on the object. In the properties box, change the value for V_x to 3 m/s. When you close the properties box, an arrow should appear on the object. If one does not, then click once on the square and select the **Define** menu item. Select the vectors item and choose velocity. A check box should appear. Also, add the acceleration vector. If vector lengths appear too small, then select the Vector Lengths menu item from the Define menu and adjust the lengths of each vector. Good values for the Vector Lengths are 0.6.



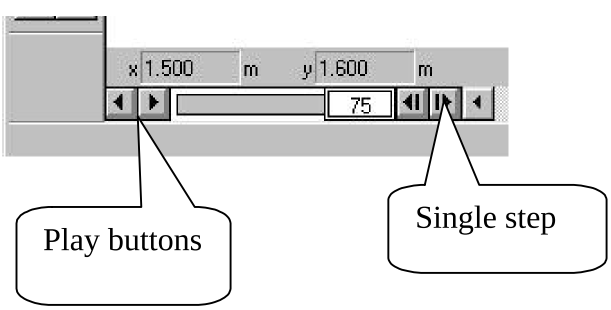
Now we will give the object acceleration by adding a Force. Choose the force button from the buttons on the left. Click and drag the force. Rotate the arrow such that it points to the right and drag it until its end touches the square object. Double click on the force and change its properties to 1.0 Newton and make sure that it is all in the positive x-direction. Your screen should look like the fragment shown to the left.



Click on the run button and observe the motion and the size of the acceleration and velocity arrows.

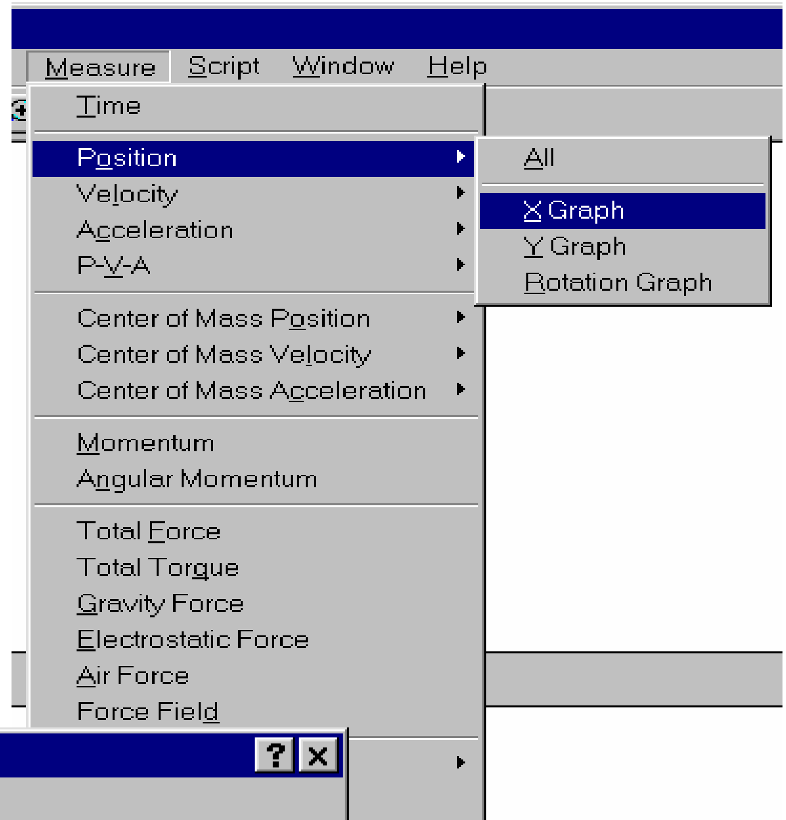
Describe the direction and lengths of the velocity and acceleration arrows as the object travels across the rectangle.

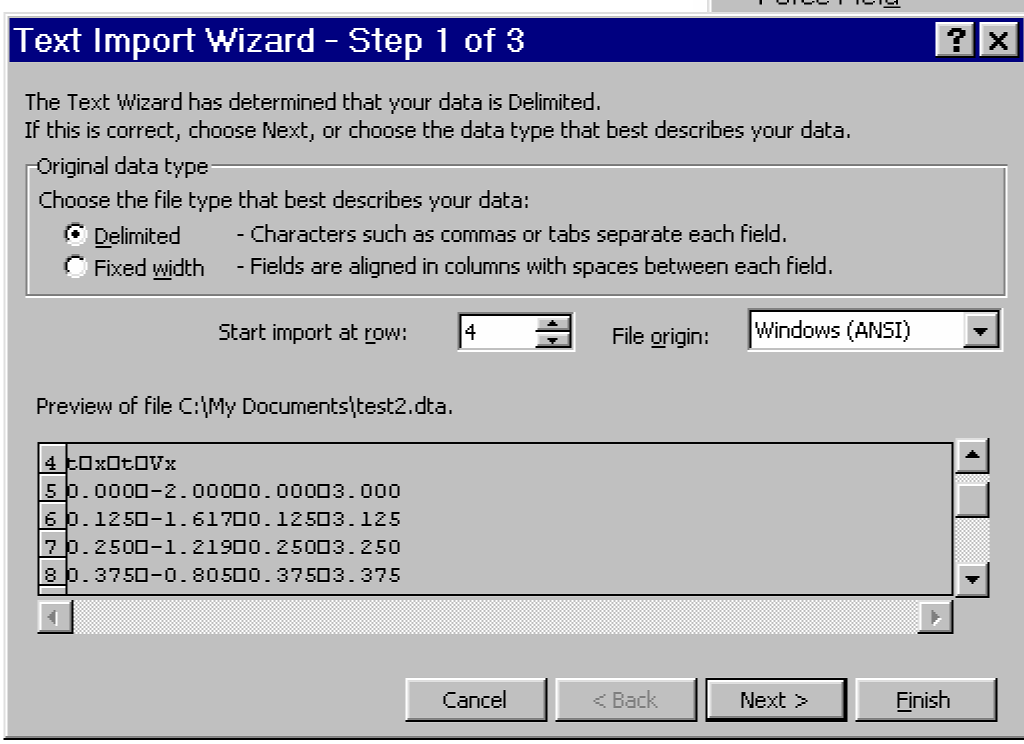
The simulations often go really fast. So you can stop the simulation and then restart it, or even replay the simulation and step through it frame by frame. If you look at the lower right hand corner of the IP window, you will see a scroll bar that looks like the one in the figure below. You can play the situation backwards, or replay it forwards (when it is playing a pause button appears). You can also single step through the motion forwards and backwards using the single step button



It would be nice to have a graphical representation of this motion also. We can add position, velocity and acceleration graphs by clicking once on the object of interest (the square object) and then selecting the **Measure** menu. Add an X-position graph and an X-velocity graph. You should also measure the "Force" applied to the car by selecting the "total force" item from the **Measure** menu. When you look at the forces listed you will see values for the x-component of the force, the y-component of the force and the net force (|F|). Now you can run the simulation again.

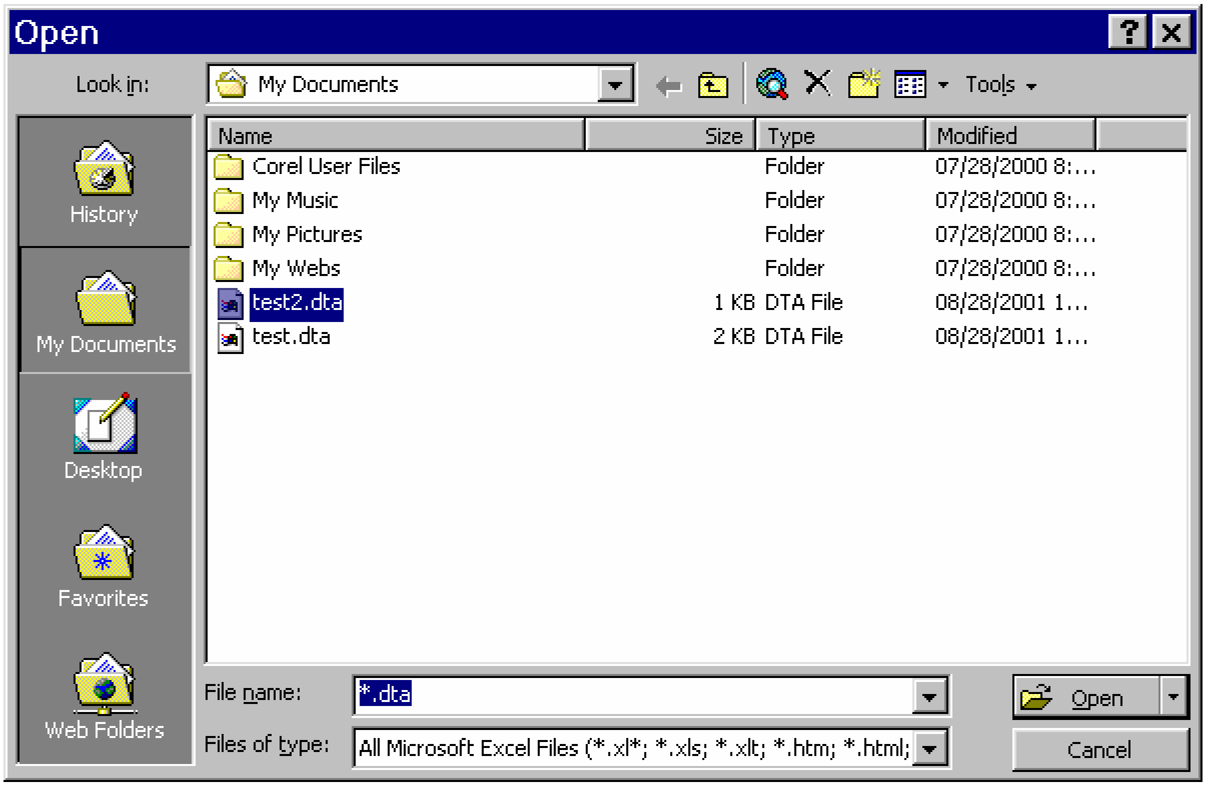
To get a printout of these graphs alone, we must perform some computer gymnastics. First go to the **File** menu and choose the export menu item. This brings up a file save window so that you can choose a file name. Be aware that your file will be appended with **".dta"**. Also pay attention to where you are saving the file. The simulation will run once you have clicked the **Export** button on the window. Remember to stop the simulation when the object has traversed your large rectangle. This completes the exporting of the data. Next, open Excel and choose **File** open. Change the file type to "*.dta" and locate your exported data. When you select it, Excel will bring up an import menu. Start importing the data at row 4 and then keep clicking next. Now you can graph your simulation data using Excel.





Make graphs of your position – time and velocity - time data. Do these graphs agree with your initial statements made on the previous page about the motion? Explain. In Interactive Physics, move the force to the opposite side of the square object and change its direction so that it is pointing to the left. If you double click on the force you can set the F_x value to –1.0 Newtons to reverse its direction.

Click the run button and observe the motion and observe the size of the acceleration and velocity arrows.

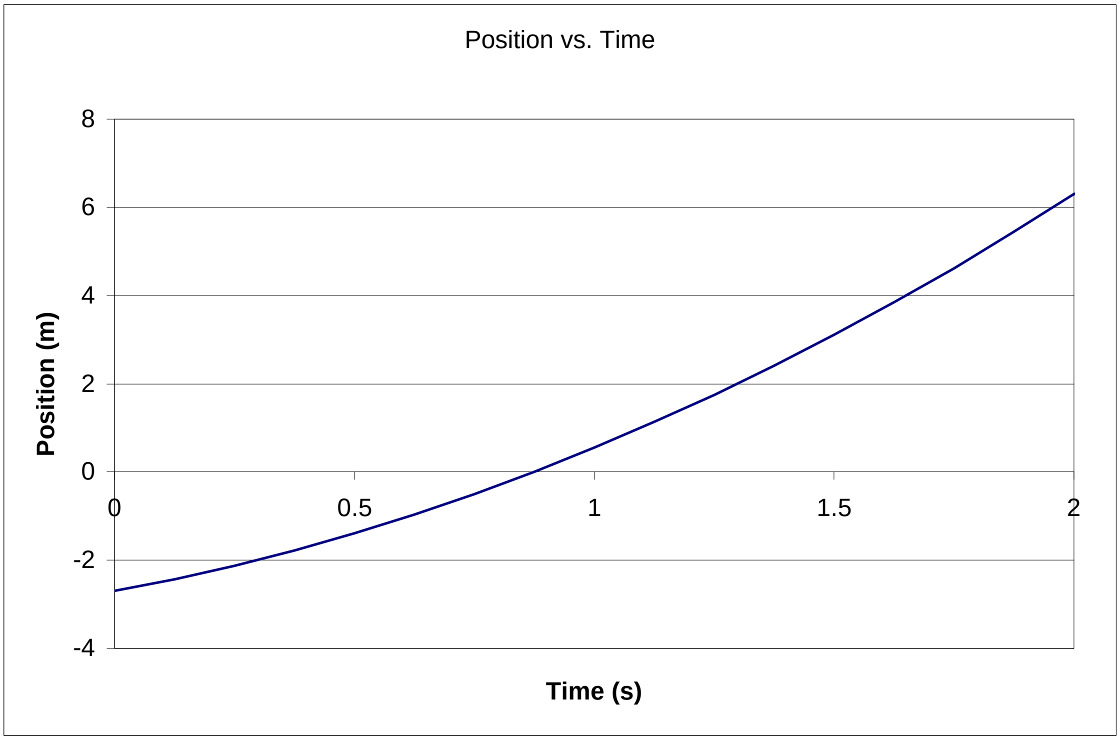


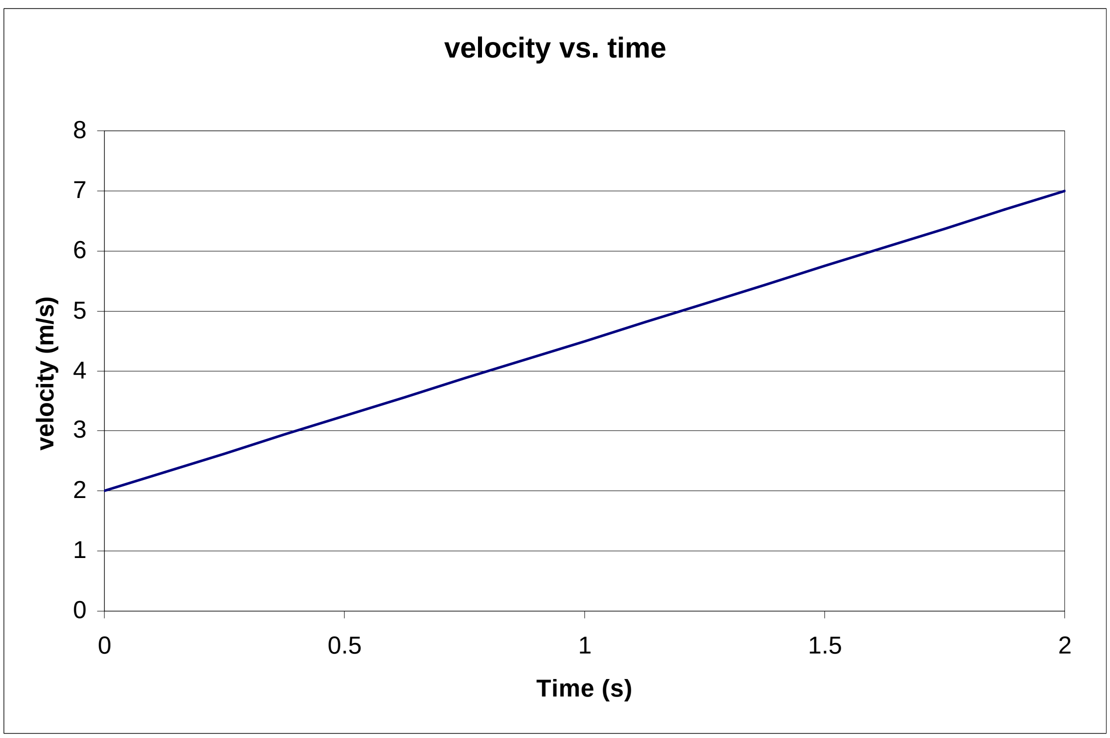
Describe the direction and lengths of the velocity and acceleration arrows as the object travels across the rectangle.

Record the position vs. time and velocity vs. time data and plot them in Excel. Do these graphs agree with your initial statements made on the previous page about the motion? Explain.

ONLY the work that you perform on following two pages is to be turned in. You will simulate two different situations.

Situation 1: A 2.5 N exerts a force on a 1kg block on a horizontal frictionless plane produces these position-time and velocity-time graphs.

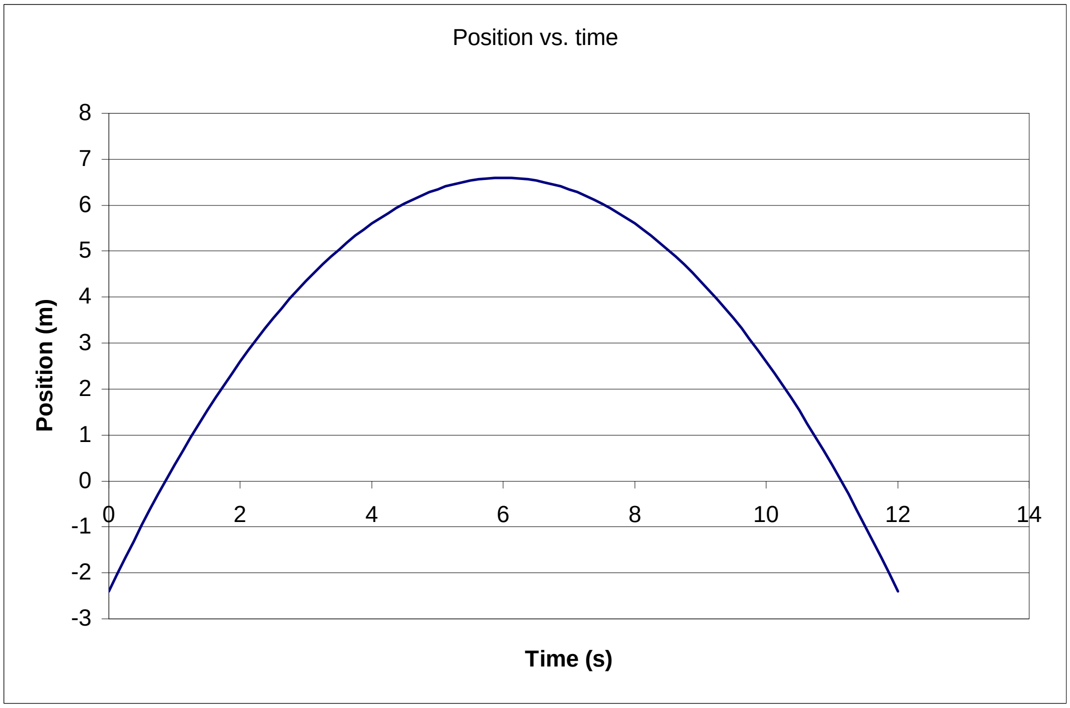


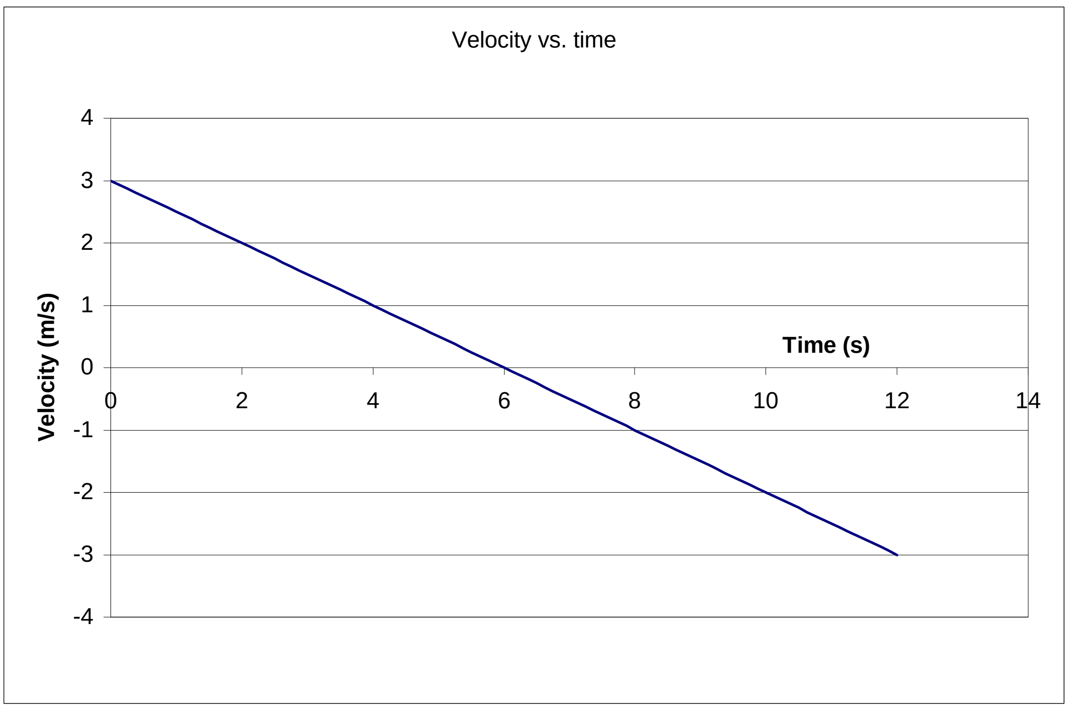


A) Describe the motion situation (acceleration, direction of acceleration, initial velocity, etc.) that would produce the position - time and velocity – time graph. Your description must be both qualitative and quantitative

B) Develop the simulation that produces this position time graph and use IP to determine the motion. Make a graph of the position of the block vs. time and the velocity along the plane vs. time from your Interactive physics simulation.

Situation 2: A 1kg block starts at the left of a frictionless plane and a force of 0.5N is exerted on the block. The position-time and velocity-time graphs for the block are shown below.





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