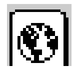
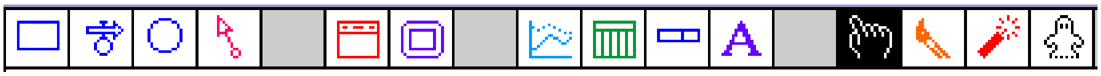
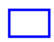
Simple Kinematics

Student Guide

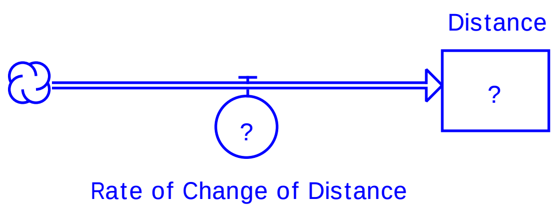
Activity 1: Building a First Model in Physics

Double click on the **STELLA** icon. When the full screen appears, **click** on the icon of the world  once. It should change to an . The top bar looks like this:



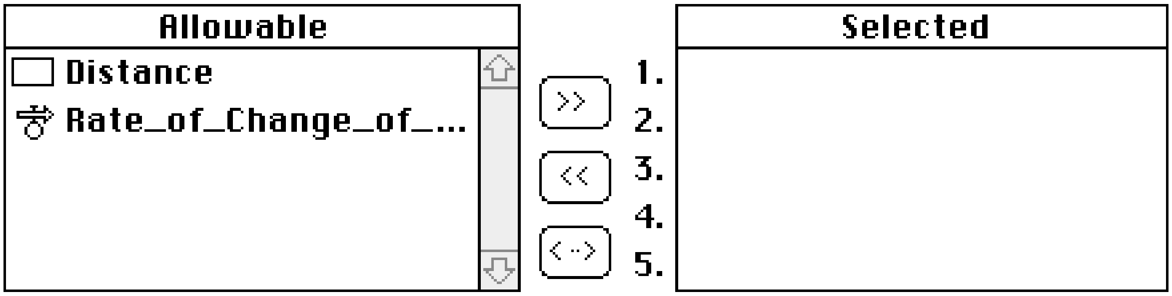
This is the source of the icons we will use to build our model. First **click** on the icon that looks like this : . This is known as a stock. Now slide your pointer out into the open field and click again. A large stock should appear with the word **Noname 1** highlighted. Before doing anything else, **type** the word **Distance.**

Now click on the icon which looks like this: . This is a flow. Slide your pointer to a position some distance to the left of the stock, **click and drag** until the arrow just touches the stock and the stock becomes shaded. Let go of the mouse button. Type the word **Rate of Change of Distance.** Your diagram should look like this:

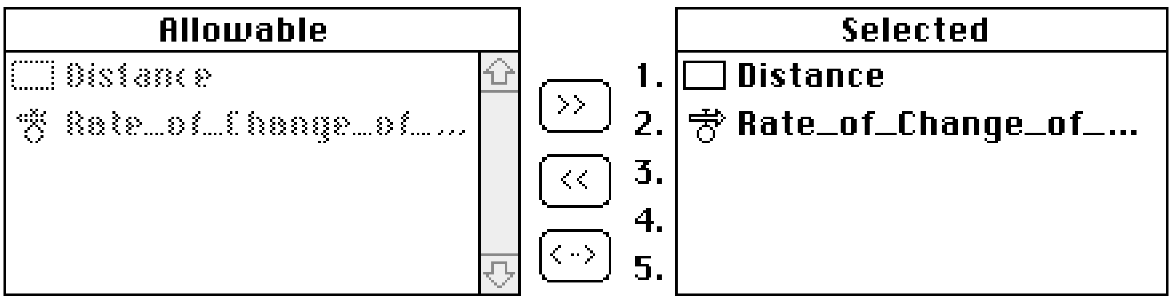


To get rid of the question marks, **double-click** on the Distance stock. When that window opens, **enter** 0 (that's a zero) and **click** on **OK.** Next **double-click** on the Rate of Change of Distance flow. When that window opens, **enter** 7 and **click** on OK.

What about units? In physics, all values should be accompanied by units. STELLA can work with any system of units, so the 0 above could be zero feet or zero meters. Likewise, the 7 could be 7 feet per sec, or 7 meters per sec or 7 miles per hour. Unfortunately, STELLA cannot do the math if the numbers have units behind them. There are two ways we can deal with this. We can remember what units we are using or we can put the units in brackets (like this {}), for example 7 {m/s}. Your instructor may want units added.
Now go back to the menu bar and **click** on the graph icon, which looks like this: . Slide your mouse pointer to a clear spot in the window and **click** again. A small graph icon should appear and immediately be replaced by a large gray graph. **Double-click** anywhere in this graph and a new window will open. In the top center of this window, you will see two boxes which look like the two on the next page:



Click on the word Distance, then click on the **>>** symbol. **Repeat** for Rate_of_Change_of_Distance. The boxes would now look like this:



Click on **OK.**

You should be back at the graph, with the word Distance in red at the top and Rate_of_Change_of_Distance in blue. From the very top menu, **Click and hold** at the word **Run**, then without letting go of the mouse button, slide down to **Run** on the menu and release. Two graph lines should form on the graph.

Question 1.1: Sketch the graph on the axes below.

Note that there are two scales on the y-axis, one for **Distance** and one for **Rate_of_Change_of_Distance.** Lock the graph by clicking on the padlock in the lower left-hand corner of the graph window.

Question 1.2*: Explain why the graphs appear as they do.

Close the graph window by **clicking** in the square in the upper left-hand corner. Bring a second graph icon to a clear spot in the window and **double-click** to open it.Select **Distance** and **Rate_of_Change_of_Distance** as the items to graph. To set the scale on Graph 2 to be the same as the scale on Graph 1, highlight **Distance**, **click** on the double-headed arrow to the right of the **Selected** Box, and set **Min** to 0 and **Max** to 90 and press **Set**. Highlight **Rate_of_Change_of_Distance**, **click** on the double-headed arrow to the right, and set **Min** to 0 and **Max** to 14 and press **Set**. **Click OK** and use this graph to answer question 1.3.

Making Predictions: Answer the following question without running the model. After you have made your predictions, you can run the model

Question 1.3: How do you think the appearance of the graphs will change and why

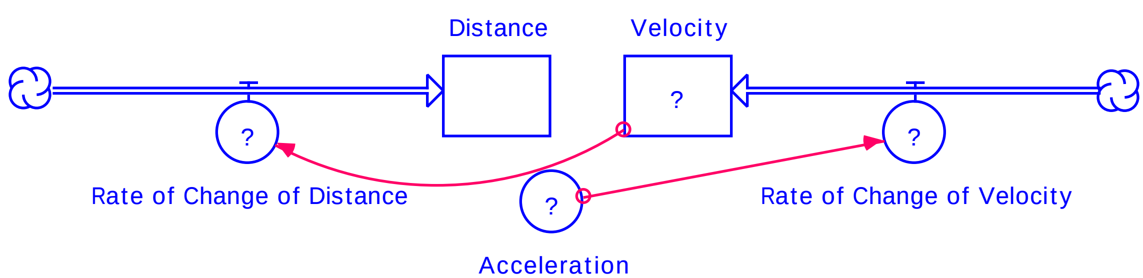
a. if the initial distance was changed to 5?

b. if the initial distance remained at 0, but the Rate of Change of Distance was changed to 3?

Now check your predictions. To do this, first close the graph window. To check your prediction to Question 1.3a, double-click on the Distance stock and replace the 0 with 5. Click OK, run the model and check Graph 2. Note any changes. To check your prediction to Question 1.3b, change the Distance stock back to 0 and then change the Rate of Change of Distance flow to 3. Click OK, run the model and check Graph 2.

Question 1.4: Were your predictions correct? Describe any discrepencies and explain why the results were different from your predictions.

Adding Acceleration: Close the graph window by clicking on the box in the upper left hand corner. Change your model so that it looks like this:



The circular icon, Acceleration, is known as a converter. It can be found to the right of the flow on the tool bar. Click there once, then position the cursor on the diagram and click again. The line with a circle on one end and an arrow on the other is a connector. It is to the right of the converter on the tool bar. Click on the red arrow in the tool bar, then position the cursor inside the Acceleration converter, click and drag until the arrow touches the Rate of Change of Velocity flow and release. Repeat for connecting Velocity to Rate of Change of Distance.

Double-click on the Rate of Change of Distance icon, and when the window opens, choose Velocity from the Required Inputs box. **Click OK**. **Double-click** on the Velocity icon and **type 0** (zero) and **OK**. **Double-click** on the Rate of Change of Velocity icon and choose Acceleration from the Required Inputs box and **OK**. **Double-click** on the Acceleration icon and **type 3** and **OK.**

Question 1.5: Earlier the Rate of Change of Distance was equal to a constant (7). Why can we now equate Rate of Change of Distance with Velocity?

Create a third graph as you did with the other two, but select **Distance**, **Velocity** and **Acceleration** this time. Do not set the scales. Run the model again.

Question 1.6*: Sketch the graph and explain the appearance of the graph.

Making Predictions: Answer the following question without running the model. After you have made your predictions, you can run the model

Question 1.7: Describe how you think the appearance of the graph will change and why:

a. if the initial velocity was changed to 5?

b. if the initial velocity remained at 0, but the Acceleration was changed to 5?

Run the model and check your predictions.

Question 1.8: Were your predictions correct? Describe any discrepencies and explain why the results were different from your predictions.

Activity 2: Extensions

In the first worksheet, you were asked about the effects of changing initial distances and velocities and about the effect of changing the flow values. In this activity, we will examine the effect of several changes on the model. At the same time, we will learn about some other features that STELLA has to offer.

Experiment with changing the acceleration values, the initial velocity and the initial distance. Remember to use appropriate testing procedures (change one variable at a time).   For the moment, keep all values positive.

Question 2.1*: What were the effects on the graphs when you changed each of these variables.

Question 2.2: Predict the effect of having a negative acceleration. What will all the graphs looks like, if the initial distance and velocity start at zero? You can answer with sketches.

To check your prediction, you need to make the following changes in the model. **Double-click** on the Distance stock and in the upper left corner of the dialog box, click in the Non-negative box so that it is blank (no X). Click on **OK.** Repeat this for the Velocity stock. This allows both of these variables to go negative. Now **double-click** on the Rate of Change of Distance flow and in the upper left corner of that dialogue box, click in the bi-flow bullet. Click **OK.**   Repeat for the Rate of Change of Velocity flow. This allows the flows to add or subtract amounts from the stock. Now change the acceleration to a negative value (try -3) run the model and observe the graph.

Question 2.3*: Sketch and explain the appearance of the graph.

Model a car accelerating, traveling at constant velocity and then decelerating. **Double-click** on the acceleration converter. Type the following in place of the value you used above

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If (Time < 3) then 5 else if (time >9) then -5 else 0
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This statement says, that if time is less than 3 seconds, the car will accelerate at 5, it will stop accelerating at all between 3 and 9 seconds and then at 9 seconds, it will decelerate at the rate of -5.

Question 2.4: What do you think the velocity and distance graphs will look like? Why?

Run the model and observe the graphs.

Question 2.5: Compare the graph created by the model to your prediction.