Working Model 2D: Tutorial 1

Problem 10-29:

An object with an initial velocity of 25 m/s upward lands 80m below its starting point. Find its maximum height, total time in the air, and the velocity at the time of its landing.

I. Steps in Setting-Up the Drawing Area

1. Choose Accuracy from the World Menu and change the settings of the Animation Step according to the Figure 1.

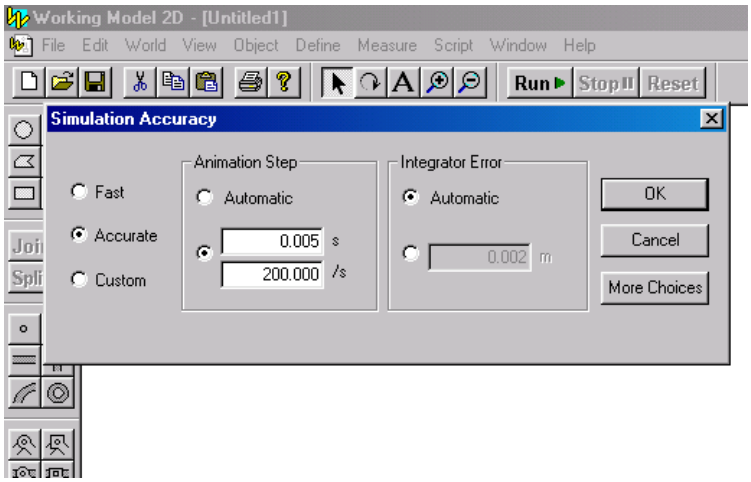


Figure 1

2. Click OK to accept these values once you make all the changes.
3. Select Number and Units … from View menu and set the Unit System to SI (degrees) and click OK.

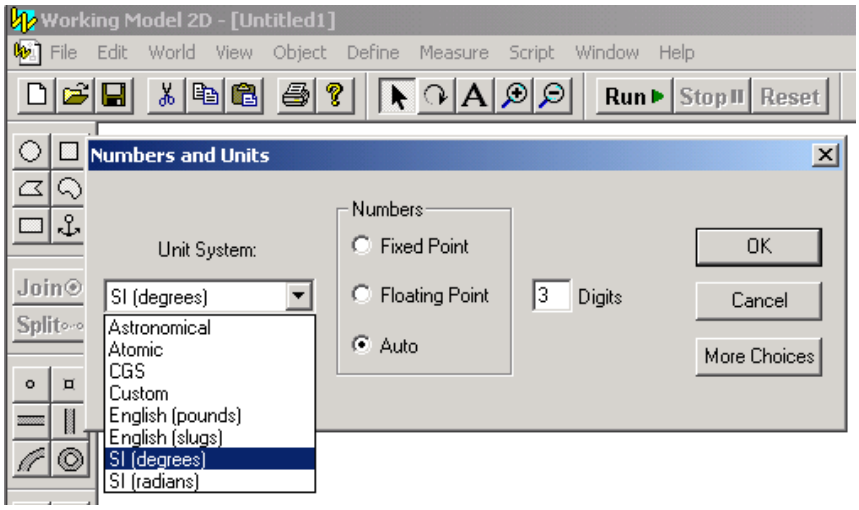


Figure 2

4. Select Workspace… from View and check the box for X, Y Axis under the Navigation category as in Figure 3 and then close the pop-up window. This will show the X and Y axis on the workspace.

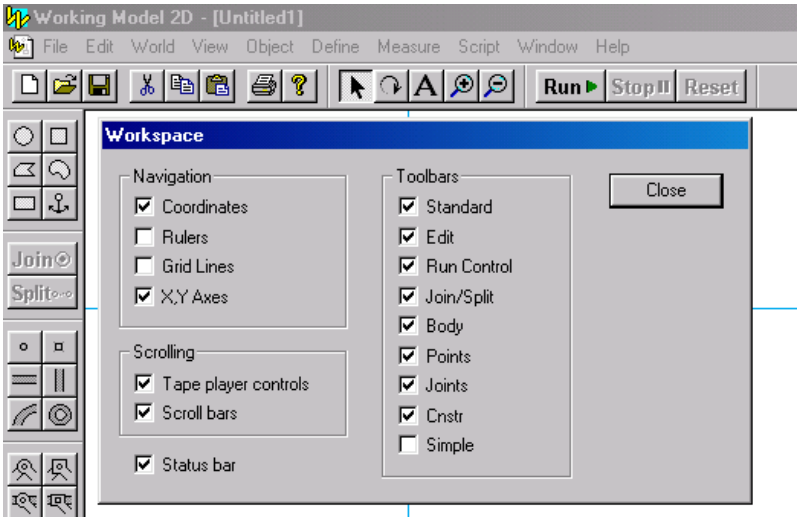


Figure 3

5. View-area of the workspace can be set by selecting the View Size… from view menu, and set the width to 100 m as in the following Figure 4.

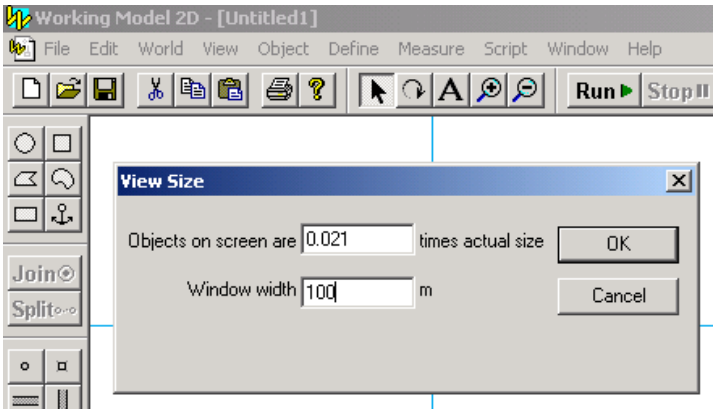


Figure 4

II. Creating Geometry

The Body Toolbar provides a variety of tools for setting-up geometry. To choose an object, click on its icon in the toolbar.

1. Click the circle tool.
2. Position the mouse pointer at any starting point in the blank area of the screen
3. Click the left mouse button and release it.
4. Drag the mouse button until circle reaches the size you want.
5. Click the left mouse button again to accept the size of the circle and finish drawing the circle.
6. If you want to change the dimensions or the location of the circle, you can use the coordinate bar as shown in the Figure 5 below.

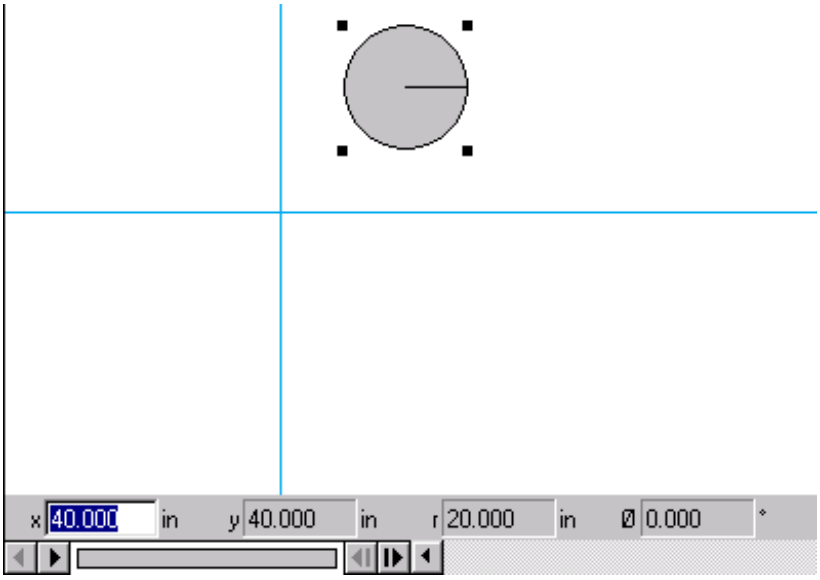


Figure 5

7. Click on the circle to select it.
8. Coordinate bar will give the center coordinates and the radius of the circle.
9. Click on the box in front of the X-coordinate and type the x coordinate of 0.0
10. Modify the y coordinate to 80.0 too. This will set the initial height of the object to 80m above the ground level (which is y=0).
11. After you enter the height as 80, the circle may have been positioned out of the work area. In that case, use the zoom-out button to zoom-out the view area. Now, the origin of the coordinate axis can be moved across the workspace by simply moving the vertical and horizontal scroll bars. By moving the scroll bars, bring the origin to an approximate position as shown in Figure 6.
12. Enter a radius of 3.0 in the radius box in order to get a proper visualization of the object.
13. Now, we can set the initial velocity of the object. Click on the object and select the Properties from Windows menu. This will give the Properties pop-up window as given in Figure 7. Change the $\mathbf{V}_y$ component of the velocity to 25 m/s. Dismiss the Properties window after you change the velocity.

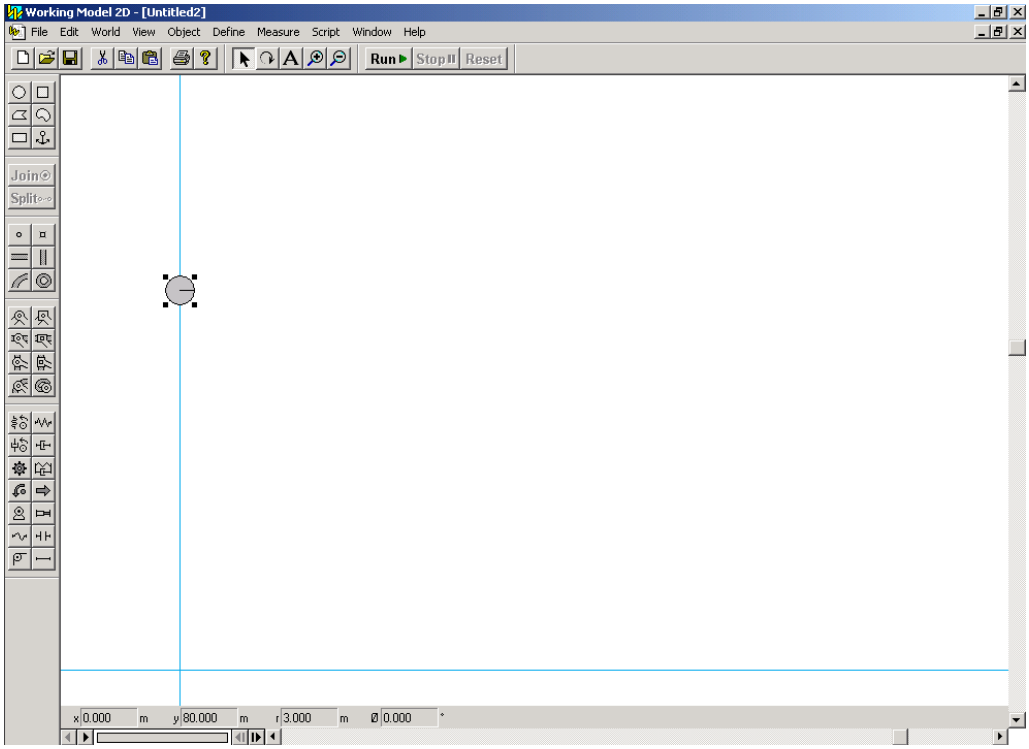


Figure 6

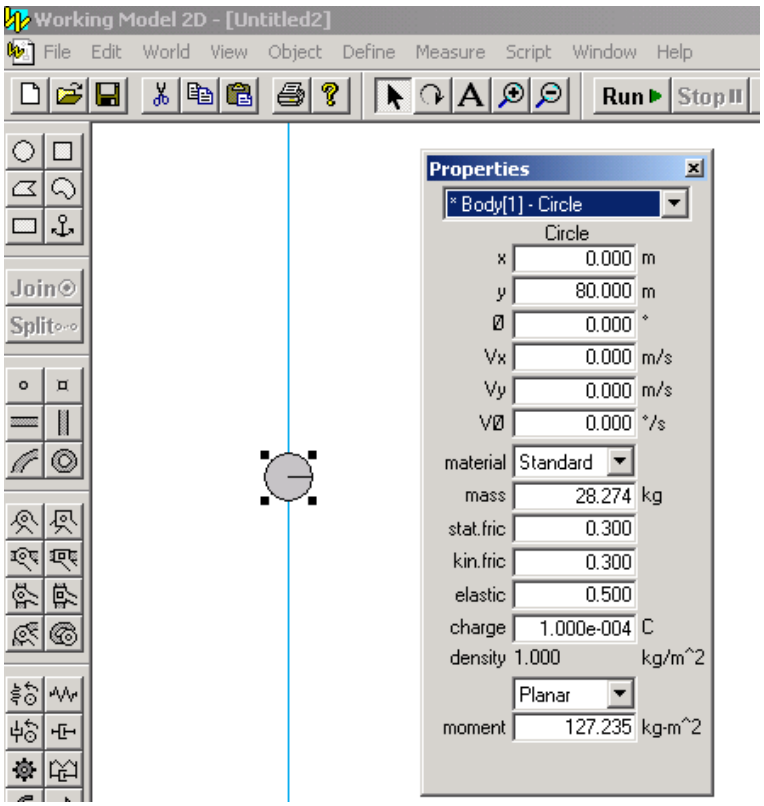


Figure 7

14. The simulation has to be terminated as the object hits the ground. In order to do that, we need to define the stopping criteria. Select the Pause Control… from World menu and click on the New Condition button. Select Stop When from drop-down menu on the left side of the Pause Control window and define the stopping criteria as shown in Figure 8. The formula has specified that the Y-coordinate of the Body 1 should not go below zero. Click OK to close the Pause Control form.

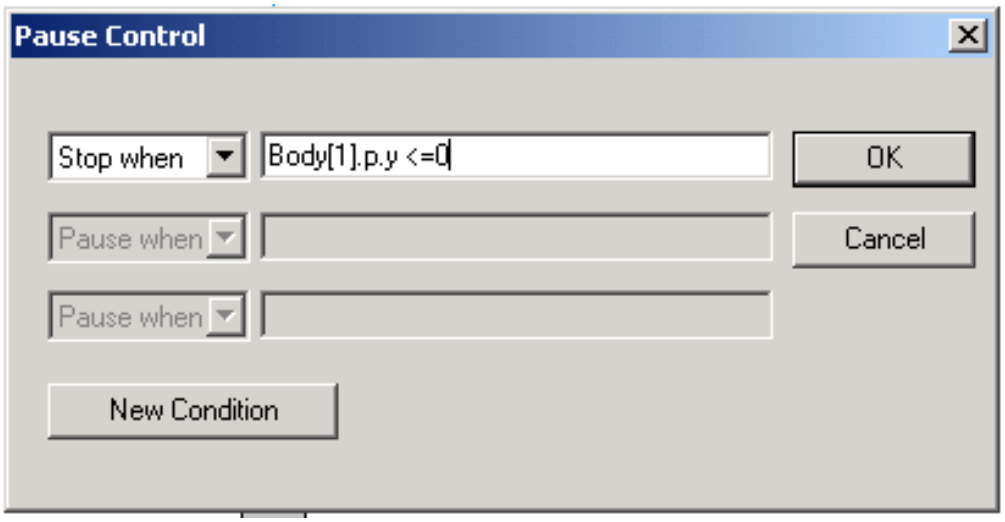


Figure 8

15. Now, the conditions are ready to run the simulation. In order to see the output of the simulation, in this case, displacement in Y direction, time, and velocity of the object, it is necessary to bring-in the corresponding meters. Select the object with a left-click on the object and go to Measure menu. Click on the Time to bring the Time graph to the working area. Similarly, go to Measure menu and select Position, and click on the Y-Graph to bring the Y Velocity Graph. Follow the same procedure for Velocity and bring the Y-Graph to measure the Y velocity. Left-click on each graph and stretch and position them on the screen to get a better view of the working area as shown in Figure 9.
16. Double-click on the Y-Position graph, and a Properties pop-up window will appear. The first half of the window defines the quantities on X and Y-axis. Go

down to the bottom half of the pop-up window and change the maximum X value to 8 (the total time taken in the problem is 7.33 Sec.). Also, change the maximum Y to 120 (See Figure 10(a)). Dismiss the Properties window after the changes.

17. Follow the same procedure to bring in the Velocity Properties pop-up window. Change the maximum X to 8. Set the minimum and maximum y1 values to –50 and 25, respectively (See Figure 10(b)). Dismiss the Properties window after the changes.

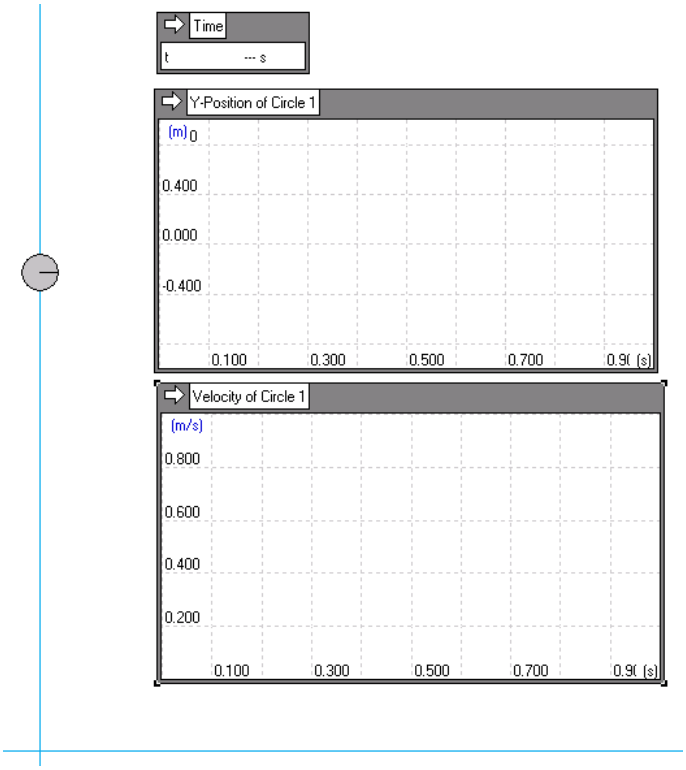
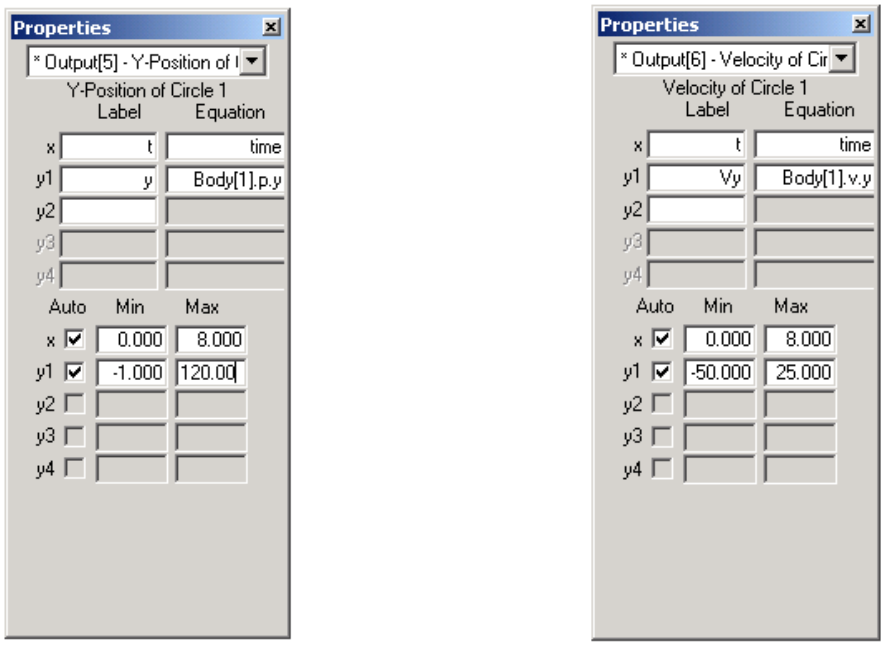


Figure 9



(a) (b)

Figure 10

18. At this point, everything is ready for the simulation. Click on the Run button to start the simulation. The object will go up and then will eventually fall down. The output is given in Figure 11. Observe the maximum height, and velocity at the landing. Compare the hand-calculated values with your simulation results.

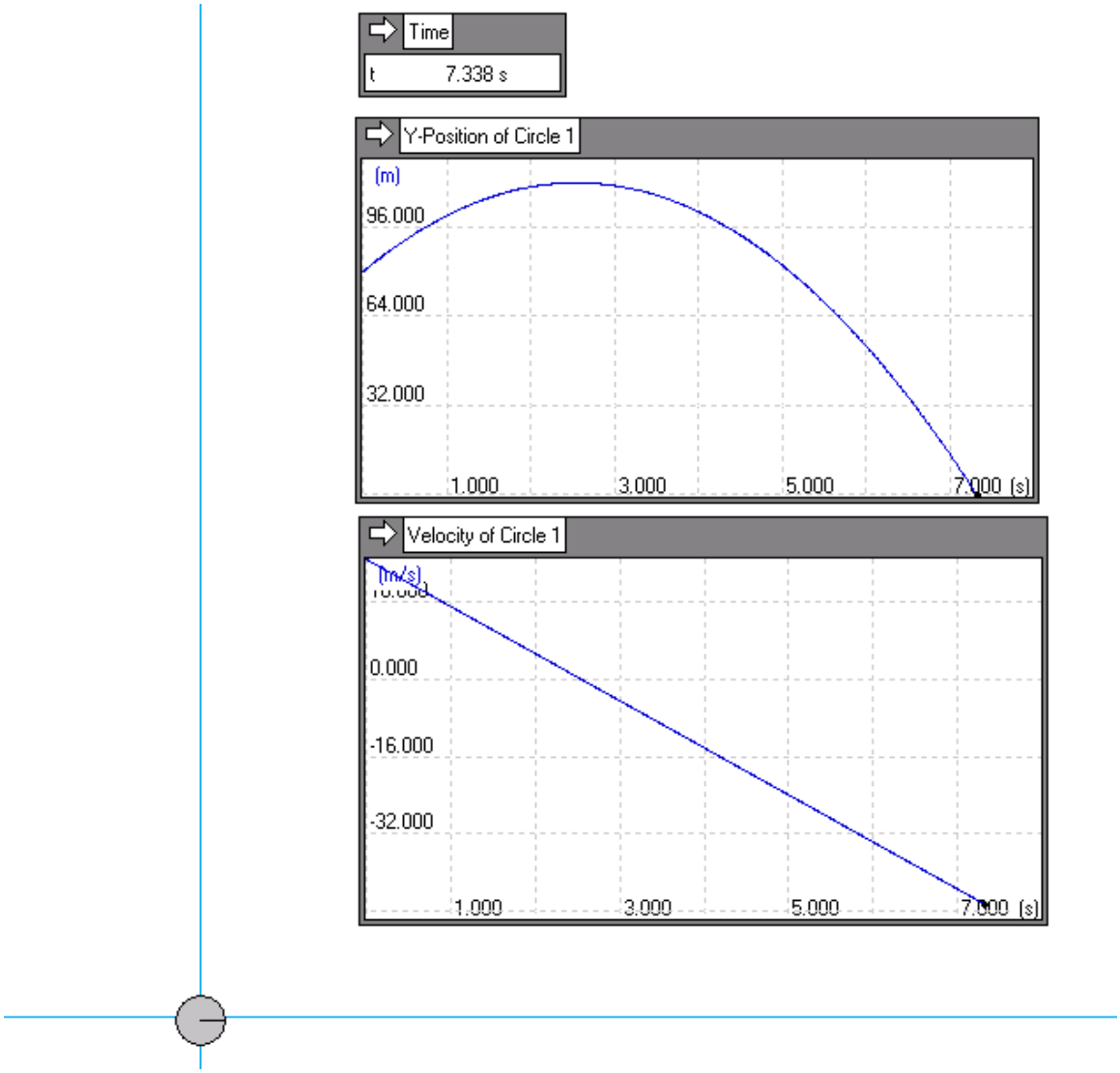

Time
t 7.338 s
Y-Position of Circle 1
(m)
96.000
64.000
32.000
1.000
3.000
5.000
7.000 (s)
Velocity of Circle 1
(m/s)
0.000
-16.000
-32.000
1.000
3.000
5.000
7.000 (s)

Figure 11