To demonstrate the usefulness of the Working Model 2-D program, sample problem 16.1 was used to determine the forces and accelerations of rigid bodies in plane motion. In this problem a cargo van with a forward speed of 30 ft/s is suddenly decelerated by the applied brakes. With the wheels locked up the van skids to rest in a distance of 20 ft. With specific dimensions of the van and the information given above, the magnitude of the normal reaction force and of the friction force at each wheel are to be determined.

The first thing that was to be done in the program was to change the units to those used in the problem. In the View menu the Numbers and Units was chosen to accomplish this task. The mass and force were changed to English units.
The first object drawn was the ground that the cargo van operated on. This was done by selecting the **Rectangle** tool and clicking on the screen, while dragging the rectangle to a desired length and height.
Clicking once on the ground allowed the dimensions of the shape to be changed. The x, h, and w variable were given the values of 15 ft, 2 ft, and 60 ft, respectively. This assured that the cargo van had plenty of room to come to a complete stop after it skidded for 20 ft.
The next step was to draw the body of the cargo van. To do this the **Rectangle** tool was selected and placed right above the ground to allow room for the addition of the wheels that were subsequently added. The dimensions of the cargo van body was given a height of 5 ft, width of 17 ft and placed 4 ft on the Y-axis. This places the center of gravity at the distance specified in the problem.
The wheels of the van were drawn next by choosing the Circle tool and clicking on the screen. A copy was made and pasted next to the other wheel to make them the same size. The ground was also anchored during this process and placed on the bottom left side of the ground rectangle.
The wheels were positioned on the van by entering the value of the rear wheel as -5 ft and a value of the front wheel as 7 ft, at the bottom of the screen. This is the position of the wheels indicated by the problem.
To fix the wheels onto the body of the van the **Pin Joint** tool was used and placed at the center of each wheel.
In this next screen the velocity and the mass of the cargo van were given by double-clicking on the body upon which time the properties window appeared. For the velocity in the x-direction a value of 30 ft/s was entered. In the same window a mass of 2000 lbs. was given to the body; an approximate weight of a light truck or van.
The breaking mechanism was added in the form of Pin Joints at the backend of the wheels. This simulated the locking of brakes and skidding.
To measure the position, velocity, and acceleration of the cargo van the point element at the center of mass of the body was selected. Measure is selected in the menu and all three of these options were chosen.
The mass of the wheels were then entered by double-clicking on the wheels and using a mass of 1.4 lbs.
The kinetic friction coefficient specified in the sample problem was used in this model. By double-clicking on the two wheels and on the ground a value of 0.699 was entered in the appropriate properties window.
In the View menu the Workspace option was selected. This allowed the Ruler, Gridlines, and X-Y axis to be used. This made it possible to know the position of the cargo van while it came to rest.
To be able to read the normal reaction forces and the friction forces the ground was selected by clicking once then, while holding the shift button down, the rear tire was selected. The same procedure was performed to read the front wheel forces.
Velocity and Acceleration vectors were displayed by selecting the center of mass and selecting Define menu where these options were chosen.
With the values given in the original problem and the assumed weight of the cargo van it was determined that as the vehicle skidded to a stop the reactions at each wheel (normal and friction) followed the solution equations of

\[
\begin{align*}
N_{\text{front}} &= 0.5N_B = 0.325W \\
F_{\text{front}} &= 0.5F_B = 0.227W \\
N_{\text{rear}} &= 0.5N_A = 0.175W \\
F_{\text{front}} &= 0.5F_A = 0.122W
\end{align*}
\]

which correspond to one of the two wheels in the back of the cargo van. With a total weight of 2000 lbs, a normal and friction force of the rear of the van was 701.8 lbs and 490.5 lbs, respectively. For the front of the vehicle normal and friction forces were 1300.9 lbs and 909.3 lbs, respectively. The deceleration of the cargo van was also determined to be 22.49 ft/s² and a total distance traveled after breaks were applied of 20.4 ft.

The very small errors obtained may be due to the weight estimate given to the cargo van and/or the wheels. With very close approximations, the Working Model 2-D program was useful in determining forces and accelerations of plane motion of rigid bodies.