Position and Velocity Graphs

Contents

NOTE: This is a continuation of the previous assignment about Force and Work Done.

Last week, we calculated the work done when a block of mass, $\boldsymbol{m}$, (in pounds) is being pushed across a horizontal surface with a constant acceleration, $\boldsymbol{a}$, (in feet per second squared) over a certain distance, $\boldsymbol{d}$ (in feet).

In this assignment, we are going to calculate the block's position and velocity at different time intervals and plot the graphs.

Total Time for the Motion

We want to calculate the total time for the motion based on the given distance and acceleration, you would use the kinematic equation:

$$\boldsymbol{d = \frac{1}{2}at^2}$$	Eq 1

Solving for time (t):

$$\boldsymbol{t = \sqrt{\frac{2d^2}{a}}}$$	Eq 2

Position and Velocity

The position of the object at a given time is given from the equation:

$$x = x_o + v_o t + \frac{1}{2} a t^2$$	Eq 3

Velocity of the object at a given time is given from the equation:

$$v = v_o + at$$	Eq 4

where,

- x_o is the initial position of the object. **We can consider the starting position of the object to be zero.** The distances are measured from this starting point.
- v_o is the initial velocity. **Since the object is at rest when pushed, this would be zero.**
- t is the time
- a is the acceleration of the object.

When you substitute $x_o = 0$ and $v_o = 0$ to equations 3 and 4 we can reduce the equations to

$$x = \frac{1}{2} a t^2$$	Eq 5
$$v = at$$	Eq 6

linspace Function

The linspace function in MATLAB is used to generate linearly spaced vectors. It creates a vector of evenly spaced points between a specified start and end value. The syntax for linspace is:

linspace(start, end, number_of_points)

- **start**: The starting value of the vector.
- **end**: The ending value of the vector.
- **number_of_points**: The number of points you want to generate between the start and end values.

For example, linspace(0, 10, 5) will generate the vector [0, 2.5, 5, 7.5, 10].

This is useful for creating time intervals for plotting the velocity and position of the block over time.

Assignment

You will need your Matlab program **Wk02ForceAndWork.m**

- Open **Wk02ForceAndWork.m**
- Save **Wk02ForceAndWork.m** as **Wk03ForceAndWorkGraph.m**

Task 1: Re-state the problem

- Include the problem in your own words as comments.

Task 2: Calculate Total Time for the Motion

- Calculate the total time using the kinematic equation.
- Place this calculation after the work done calculation.
- Display total time after displaying work done.

Task 3: Create a Vector to Store the Different Time Intervals

At the end of the program:

- Create a vector **time_intervals** using the **linspace** function to store the different time intervals.
- **start**: 0
- **end**: total_time
- **number_of_points**: 100

Task 4: Calculate the Position at Each Time Interval

- Use the position formula.
- This calculation will operate against each element in the vector simultaneously.

Task 5: Calculate the Velocity at Each Time Interval

- Use the velocity formula.
- To square each element in the vector, use the following code. The . (dot) tells Matlab to square each element of the vector.

```
time_intervals.^2
```

Task 5: Plot the position and velocity of the object as a function of time.

- The accuracy of the graph depends on the number of intervals graphed. Try changing the number of points in the linspace function to 4.

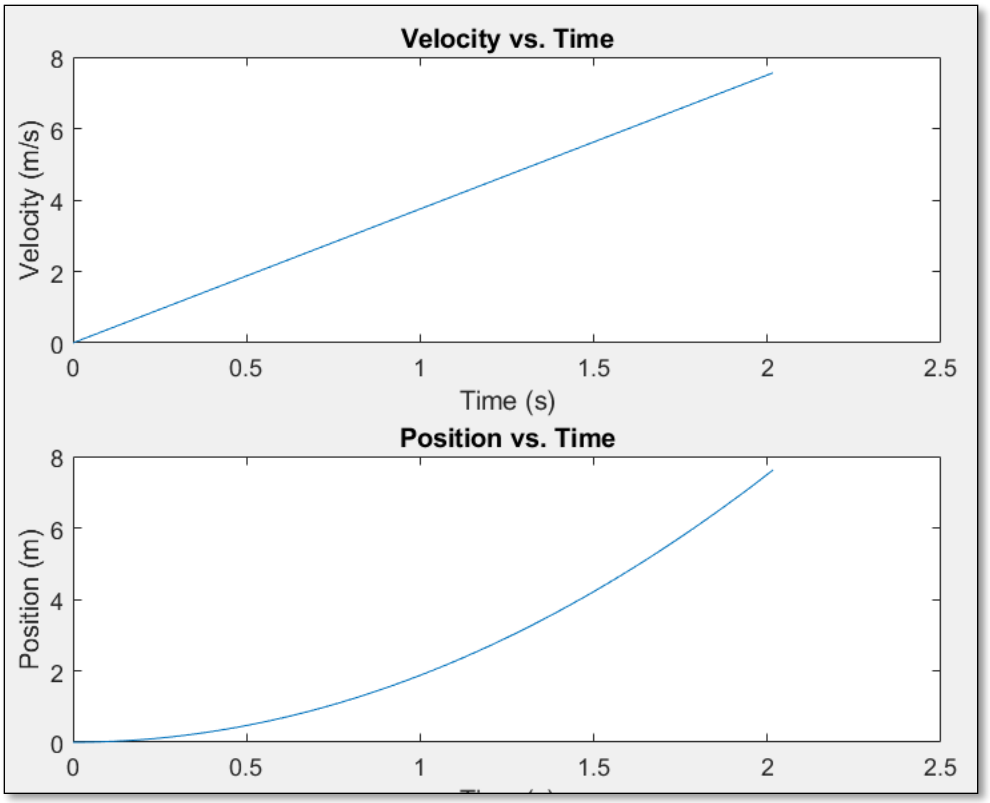
```
% Create plot
figure;

% Plot the velocity as a function of time as a subplot
subplot(2,1,1);
plot(time_intervals, velocity);
title('Velocity vs. Time');
xlabel('Time (s)');
ylabel('Velocity (m/s)');

% Plot the position as a function of time as a subplot
subplot(2,1,2);
plot(time_intervals, position);
title('Position vs. Time');
xlabel('Time (s)');
ylabel('Position (m)');
```

Example run:

```
-------- Force and Work Calculator --------
Enter mass in pounds: 20.3
Enter acceleration in feet per second^2: 12.3
Enter distance in feet: 25
Block of mass 9.21 kg is pushed with an acceleration of 3.75 m/s^2.
Work Done: 263.05 joules
Total Time: 5.57 seconds
```



Assignment Submission

1. Submit properly named and commented script file.
2. Attach a text file or screenshot showing the successful execution of the script.
3. Attach all to the assignment in Blackboard.