1 Introduction

The purpose of this lab is to show the connection between acceleration, $a$, velocity, $v$, and displacement, $x$. You should read the course notes to familiarize yourself with the relationships (in terms of anti-differentiation). Here we will use the fact that

$$\Delta v \approx \sum a(t)\Delta t \quad \text{and} \quad \Delta x \approx \sum v(t)\Delta t$$

to calculate (using the spreadsheet) an approximation for the velocity and the displacement, given the acceleration of some particle. Although the calculation can also be done by integration, our point here is to show the numerical version that uses the spreadsheet, so we have chosen acceleration functions $a(x)$ which are difficult to integrate by hand.
2 Problems

Note: This lab, and other labs contain several very similar sets of problems.

You only do ONE problem set.
Your student number is used to indicate which problem is assigned to you.

- Do Problem Set 1 if the last digit of your student number is a 1 or a 6
- Do Problem Set 2 if the last digit of your student number is a 2 or a 7
- Do Problem Set 3 if the last digit of your student number is a 3 or a 8
- Do Problem Set 4 if the last digit of your student number is a 4 or a 9
- Do Problem Set 5 if the last digit of your student number is a 5 or a 0

Note: Please label each graph carefully with your name, student number, lecture section, and indicate which problem set you did. Also, don’t forget to write the answers to all questions on the bottom of the page, directly under the graph.

If you are asked to hand in more than one page, please staple the pages.

Survey
Please fill in the survey for this lab after completing the problem set.

For more information go to Surveys
2.1 Problem Set 1

A particle accelerates from rest, its acceleration depending on time as follows:

\[ a(t) = \frac{t^{3.1}}{3 + 3t^{2.2}} \frac{m}{s^2}. \]

Use the spreadsheet to compute the velocity of the particle over the time interval \(0 \leq t \leq 3.5\). Determine the displacement of the particle over the same time interval. How far did the particle move altogether, and what were its velocity and its acceleration at \(t = 3.5\)?

You should hand in one page showing

- The graphs of acceleration, velocity, and position over the time interval \(0 \leq t \leq 3.5\).
- The values you find for the final acceleration, velocity, and displacement (at time \(t = 3.5\)), accurate to 1 decimal place.

We suggest that you use the approximation techniques of Lab 2 to compute the necessary integrals. The accuracy of your approximation is controlled by the step size \(\Delta t\). If you are worried that your results are not accurate enough, then decrease your step size and see how much your final values change.

You may find it helpful to use the “copy” command, under the “edit” menu, to make long columns of numbers in Maths sheet.
2.2 Problem Set 2

A particle accelerates from rest, its acceleration depending on time as follows:

\[ a(t) = \frac{t^{2.9}}{1 + 3t^{2.3}} \text{ m/s}^2. \]

Use the spreadsheet to compute the velocity of the particle over the time interval \(0 \leq t \leq 4\). Determine the displacement of the particle over the same time interval. How far did the particle move altogether, and what were its velocity and its acceleration at \( t = 4 \)?

You should hand in one page showing

- The graphs of acceleration, velocity, and position over the time interval \(0 \leq t \leq 4\).
- The values you find for the final acceleration, velocity, and displacement (at time \( t = 4 \)), accurate to 1 decimal place.

We suggest that you use the approximation techniques of Lab 2 to compute the necessary integrals. The accuracy of your approximation is controlled by the step size \( \Delta t \). If you are worried that your results are not accurate enough, then decrease your step size and see how much your final values change.

You may find it helpful to use the “copy” command, under the “edit” menu, to make long columns of numbers in Mathsheat.
A particle accelerates from rest, its acceleration depending on time as follows:

\[ a(t) = \frac{3t^{3.6}}{2 + 3t^{2.2}} \text{ m/s}^2. \]

Use the spreadsheet to compute the velocity of the particle over the time interval \( 0 \leq t \leq 3.5 \). Determine the displacement of the particle over the same time interval. How far did the particle move altogether, and what were its velocity and its acceleration at \( t = 3.5 \)?

You should hand in one page showing

- The graphs of acceleration, velocity, and position over the time interval \( 0 \leq t \leq 3.5 \).
- The values you find for the final acceleration, velocity, and displacement (at time \( t = 3.5 \)), accurate to 1 decimal place.

We suggest that you use the approximation techniques of Lab 2 to compute the necessary integrals. The accuracy of your approximation is controlled by the step size \( \Delta t \). If you are worried that your results are not accurate enough, then decrease your step size and see how much your final values change.

You may find it helpful to use the “copy” command, under the “edit” menu, to make long columns of numbers in Mathsheet.
2.4 Problem Set 4

A particle accelerates from rest, its acceleration depending on time as follows:

\[ a(t) = \frac{2t^{3.2}}{3 + 3t^{2.9}} \text{ m/s}^2. \]

Use the spreadsheet to compute the velocity of the particle over the time interval \(0 \leq t \leq 4\). Determine the displacement of the particle over the same time interval. How far did the particle move altogether, and what were its velocity and its acceleration at \( t = 4 \)?

You should hand in one page showing

- The graphs of acceleration, velocity, and position over the time interval \(0 \leq t \leq 4\).
- The values you find for the final acceleration, velocity, and displacement (at time \(t = 4\)), accurate to 1 decimal place.

We suggest that you use the approximation techniques of Lab 2 to compute the necessary integrals. The accuracy of your approximation is controlled by the step size \(\Delta t\). If you are worried that your results are not accurate enough, then decrease your step size and see how much your final values change.

You may find it helpful to use the “copy” command, under the “edit” menu, to make long columns of numbers in Mathsheet.
2.5 Problem Set 5

A particle accelerates from rest, its acceleration depending on time as follows:

\[ a(t) = \frac{t^{2.6}}{2 + 2t^{3.3}} \text{ m/s}^2. \]

Use the spreadsheet to compute the velocity of the particle over the time interval \(0 \leq t \leq 3.5\). Determine the displacement of the particle over the same time interval. How far did the particle move altogether, and what were its velocity and its acceleration at \(t = 3.5\)?

You should hand in one page showing

- The graphs of acceleration, velocity, and position over the time interval \(0 \leq t \leq 3.5\).
- The values you find for the final acceleration, velocity, and displacement (at time \(t = 3.5\)), accurate to 1 decimal place.

We suggest that you use the approximation techniques of Lab 2 to compute the necessary integrals. The accuracy of your approximation is controlled by the step size \(\Delta t\). If you are worried that your results are not accurate enough, then decrease your step size and see how much your final values change.

You may find it helpful to use the “copy” command, under the “edit” menu, to make long columns of numbers in Mathsheet.