Let’s say you have a car, starting at rest, with an acceleration defined to be:

1. How fast is it moving after 0.02s?
2. Where is it after 5s?
3. What it changed to , where would it be after 10s?

This example has a few different parts, where our acceleration is not the nice simple constant. In the previous example, the acceleration was constant, so you could solve it without using simulation. However, with an acceleration that’s not constant, the only way you can solve it is through simulation.

Let’s get started with part a). First, we make our table and put in our initial conditions. Again, we use time, position, velocity, and acceleration for our table. We can set time to start at 0 and position to start at 0, since the problem doesn’t specify a starting position. Initial velocity is 0, since the car starts at rest. To find the initial acceleration, we plug in our time into the acceleration given by the problem, so:

So the initial acceleration is 0 as well.

|  |  |  |  |
| --- | --- | --- | --- |
| Time (t) | Position (x) | Velocity (v) | Acceleration (a) |
| 0 | 0 | 0 | 0 |
|  |  |  |  |
|  |  |  |  |

Now let’s take our first step and go to 0.01 seconds, where we’re still going to be using these two expressions.

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I don’t want you to memorize these now, remember, these just come from the definitions of velocity and acceleration. These just the definitions of these quantities rewritten, so it’s not a new equation, it’s the same definitions we’ve been exploring in this entire preparation. Again, we plug in the initial values into the two expressions, so:

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We also have to solve for our new acceleration using the formula given in the problem. Before we move on, notice that there’s a in our expressions for final position and velocity, but there is a in the formula for acceleration. Normally, these are interchangeable, but in this problem, they mean two separate things. The change in time , so the time steps, while is the total time up to that step, so it’s important to keep in mind this distinction. Solving for the new acceleration gives us:

And our new table looks like:

|  |  |  |  |
| --- | --- | --- | --- |
| Time (t) | Position (x) | Velocity (v) | Acceleration (a) |
| 0 | 0 | 0 | 0 |
| 0.01 | 0 | 0 | 0.0005 |
|  |  |  |  |

Repeating the process for 0.02 gives us:

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Notice that 0.02 is used for the time in the acceleration. Again, keep in mind the distinction between and in the problem. Filling out the table gives us:

|  |  |  |  |
| --- | --- | --- | --- |
| Time (t) | Position (x) | Velocity (v) | Acceleration (a) |
| 0 | 0 | 0 | 0 |
| 0.01 | 0 | 0 | 0.0005 |
| 0.02 | 0 | 0.000005 | 0.002 |

So the answer to the question is that the car is moving 0.000005 m/s after 0.02 seconds.

Alright, so now we’ve solved this problem by hand for up to .02 seconds, great. The next question is, where is it after five seconds? Well, doing this by hand in one one-hundredth of a second increments for five seconds is going to take us a really long time. You could do it, but you’d be at it for quite a while. This is where the benefit of using a computer to solve the problem will come into play. Since simulation is mostly just a process, you can have a computer program, like Excel or Google Spreadsheets, run through the process for you. We’ll be going over how to do this in class.