PHYS 380 - Fall 2024

Assignment 8

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Problem 1

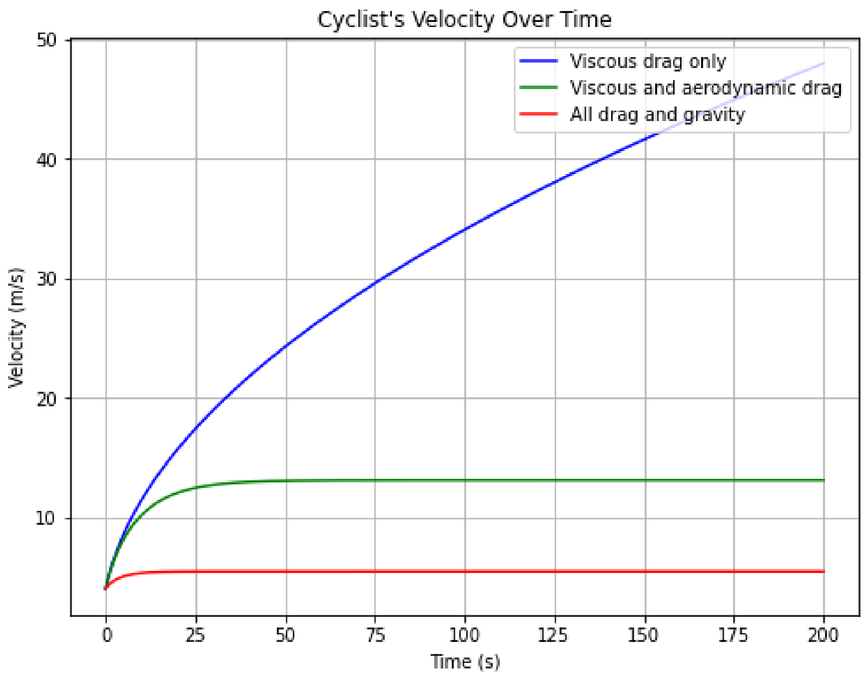

Figure 1: The one dimensional velocity of a bicycle experiencing various retarding forces. (Surface Gradient: 0.1)

This problem includes three parts, each part corresponding to the addition of a retarding force which affects the bicycle's motion. These three forces are the Stokes' viscosity drag, kinetic drag, and gravity. Consider figures 1 and 2. The first figure includes kinetic drag, Stokes' drag, and gravity with a positive surface gradient. What we see is that the trajectory with only the Stokes' term blows up very quickly and is indistinguishable from the ideal case with no forces; this makes sense, as the governing parameter in that term is the viscosity of the air (or the traversed medium, in general) which is, for air, on the order of 1 in 100000 – so, the viscous term is essentially negligible. Interesting things start to happen when drag quadratic in velocity is added. This term has more to do with the speed of the bicycle and the geometry of the rider, and so it provides the dominant effect. We see from the plot, that steady state is reached after about 30 seconds. The third trajectory on the figure is

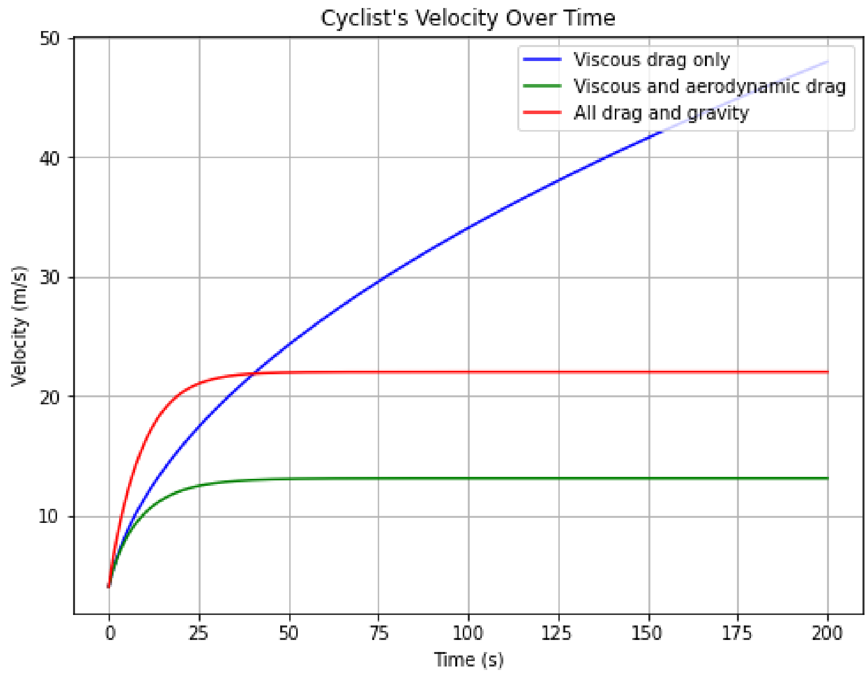

Figure 2: The one dimensional velocity of a bicycle experiencing various retarding forces. (Surface Gradient: -0.1)

one which involves all the drag forces with gravity added. We see that terminal velocity is reached much quicker in the case of positive gradient, as gravity is hindering the bicyclist and not helping. Figure 2 is the same as figure 1 but for the change in surface gradient, which is negative. We see that steady state is once again reached in about 30 seconds, however the terminal velocity is much greater than in the case of positive gradient.

Problem 2

This problem involved the simulation of a random walk. This involved using pseudo-random numbers to cause the "walker" to move either 1, -1, or 0 in either, or both, of the x and y directions each discrete time step n. The results, shown in figures 3 and 4, are consistent with expectations.

Problem 3

This problem is much the same as problem 2, except that in this problem, we are meant to calculate the average displacement-squared of 500 random walkers. This involved modifying the software written for problem 2. The results are shown in figure 5. Expectations for this plot were slightly more complicated for this scenario. One might predict randomness, as in the results from problem 2, but we see that the mean square displacement is effectively

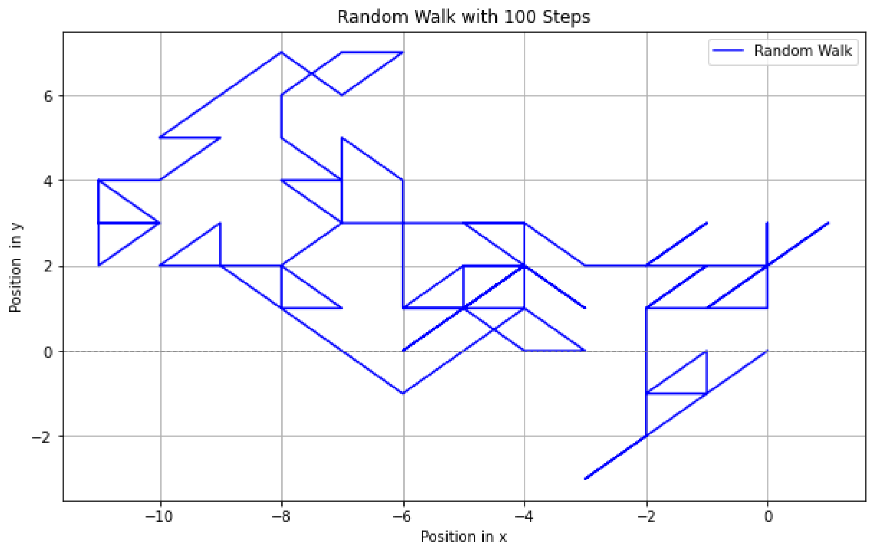

Figure 3: First instance of two-dimensional random walk.

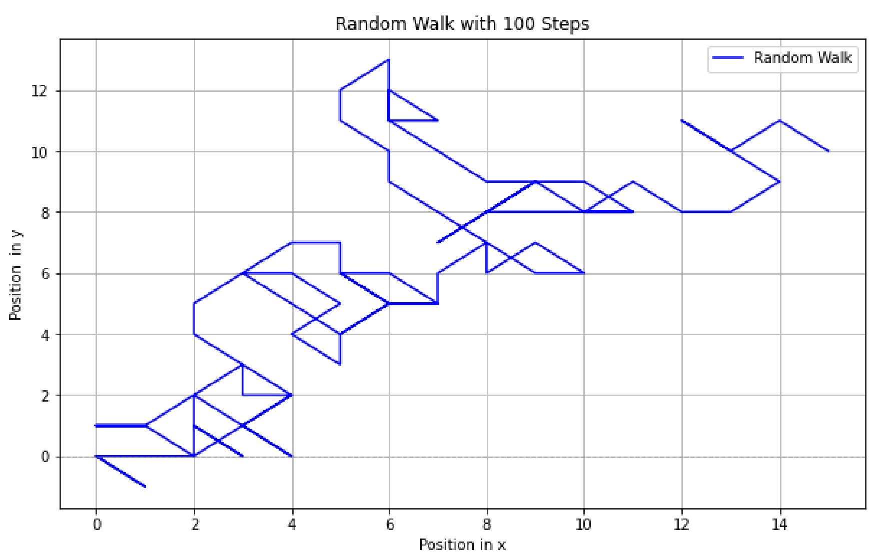

Figure 4: Second instance of two-dimensional random walk.

a linear function of (discrete) time; this means that the average displacement of a particle from its origin grows as time progresses.

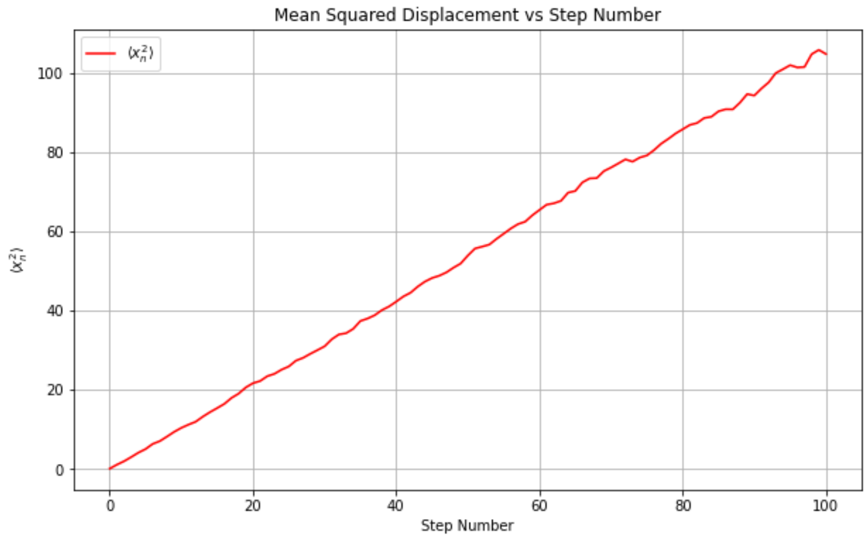

Figure 5: Mean square-displacement of 500 random walkers.