MCS/PHY 186 Homework for chapter 7.

1. Downey 7.1

Pick two of the following three questions.

2. Bicycle with drag:
   In class we used the following equation to find the speed of a bicycle pedaled by a person
   $$\frac{dv}{dt} = \frac{P}{m\,v}$$
   Where the left hand side of the equation is the acceleration and the right hand side is the force/mass. This ignores the effect of the force of drag from the air. Since the wind will slow the biker down we should subtract F_{air}/m from the right hand side, where
   $$\frac{F_{air}}{m} = \frac{\rho\, Area\, v^2}{2\, m}$$
   Use $\rho = 1.25 kg/m^3$ and $Area = 0.33 m^2$and keep the same parameters and initial conditions (starting values for variables) as for the example in class to find how long it takes the biker to reach a speed of 6m/s.

3. Population dynamics:
   The number of creatures living in an enclosure can be described by the following differential equation:
   $$\frac{dN}{dt} = a\, N - b\, N^2$$
   Where N is the number of creatures alive, a measures how quickly they reproduce and b measures how much they compete with each other. Start with two rabbits in a cage (large cage) and use the reproduction rate a=3/year and b=0.000001/year and a time step of deltaT=1yr to determine:
   i. The number of animal alive at the end of 20yrs
   ii. How long it takes the population to reach 1 million.

   If you are surprised by the results of ii in light of i you might consider looking at the population for each year of the 20yrs of part i.

4. Loan interest:
   Banks make money from you by, among other things, giving out loans. The following differential equation describes the principle, P, that you owe while you are paying back your loan given an interest rate, I, and a repayment amount, RP
   $$\frac{dP}{dt} = I\, P - RP$$
   Using an initial loan amount of $1000, and interest rate of 15%/year, a monthly repayment of $20, and deltaT=1 month to find:
   i. The time it takes to repay the entire loan
   ii. The amount of money the bank makes/you lose in this transaction.