Math 430 and Math 635: Analytical and Computational Neuroscience
Fall 2001. Prof. V. Booth
Homework 2. Due: Wednesday, Sept. 27, 2001

Consider a spherical cell with radius 5 μm= 5 x 10^{-4} cm, specific membrane resistance $R_m = 10$ MΩ cm^2 and resting potential -70 mV.

1. What is its total capacitance?
2. What is its total membrane resistance?
3. What is its membrane time constant τ?
4. If the voltage is set to -50 mV at $t = 0$,
   (a) what is voltage at $t = 10$ msec?
   (b) when will voltage be within 0.5 mV of its resting potential?
   (c) draw a qualitative sketch of the voltage trajectory.
5. How much applied current is needed to maintain a steady state membrane voltage of -55 mV?
6. At $t = 0$, an applied current of (density) 2 μA/cm^2 is injected into the cell and at $t = 20$ msec, it is removed.
   (a) What is the solution for the voltage trajectory as a function of time?
   (b) Draw a qualitative sketch of this voltage trajectory.
   (c) Suppose the same experiment was done on a cell that is identical except that its specific membrane resistance $R_m = 15$ MΩ cm^2. How would its voltage trajectory differ? Sketch its voltage trajectory on the same plot.