Name: _____

**Math130: Biomodule #4**

1. A raindrop falls from a leaf according to the function

$$S(t) = -16t^2 + V_0 t + S_0$$

where $t$=time in seconds, $V_0$=initial velocity in ft/s, and $S_0$ =initial distance in meters.

   a. Find the first derivative of this function explain its meaning. Provide units in your answer.

   b. Find the derivative of your answer in part a and explain its meaning. Provide units for your answer.

2. The spread of a virus can be modeled by $V(t) = -t^2 + 6t - 4$, where $V(t)$, is the number of people (in hundreds) with the virus and $t$ is the number of weeks since the first case was observed.

   a. Find the rate of change of the spread of the virus. Provide units for your answer.

   b. When does the number of infected people reach a maximum (i.e. when does the rate of change =0)?

   c. What is the maximum number of people infected?

d. Find the average rate of change of $V(t)$ on the interval [1,3] and explain your answer.

e. Find the instantaneous rate of change of $V(t)$ at $t$=4 and explain your answer. What do you think could be going on with the spread of the virus at this time?

3. According to the fluid mosaic model of S. J. Singer and Garth Nicolson 1972, biological membranes can be considered a two-dimensional liquid where all lipid and protein molecules easily diffuse. If we consider a cell as an assembly of phospholipids, then the free potential, $P(A)$, of a cell membrane depends on the average area, $A$, of the membrane phospholipid molecule and can be described by the following equation:

$$P(A) = \frac{K}{A} + \Gamma A$$

where the interfacial force, gamma (Γ), for a phospholipid membrane is $5 \times 10^{-6}$ J/cm$^2$ and the molecular repulsion coefficient, K, is $1.25 \times 10^{-34}$ Jcm$^2$. If the optimal area, the area at which the free potential of the membrane is at a minimum, is the average surface area of the phospholipid molecule in the cell membrane, then the surface tension, $T$, of the cell membrane could be considered the rate of change of free potential.

a. Write an equation of surface tension, $T$.

b. If the free potential of a membrane is minimal when its rate of change is zero, determine the optimal area.