

Please note: some students may know some differential calculus. As a reminder to those students, **you may not take any derivatives** in this assignment. Instead, you must justify your answers some other way.

1. A population of voles at time t is given by $P = 10e^{t/4}$, where P is measured individual voles and t is measured in months.
 - a) How many voles are there at time $t = 0$?
 - b) How many voles are there one year later? Do not round your answer; express it to 5 decimal places.
 - c) What is the net change in the vole population over the first year? What are the units of your answer?
 - d) What is the average rate of change of the vole population over the first year? Express your answer to 5 decimal places in units of voles per year and **also** in units of voles per month.
 - e) What is the net change and the average rate of change of the vole population over the first three months? Express your rate of change answer in terms of voles per month.
 - f) What is the average rate of change of the vole population over the first month? Express your answer in terms of voles per month.
 - g) What is the average rate of change of the vole population over the 10 days? Express your answer in terms of voles per month. You can assume that there are 30 days in a month.
 - h) What is the average rate of change of the vole population over the first day? Express your answer in terms of voles per month.
 - i) What is the average rate of change of the vole population over the first hour? Express your answer in terms of voles per month.
 - j) What is the average rate of change of the vole population over the first minute? Express your answer in terms of voles per month.
 - k) Write down a formula for the average rate of change of the population over time $t = 0$ to time $t = T$. Your answer should be a formula in terms of T .
 - l) What happens when you plug $T = 0$ into your formula?
 - m) If you had to answer the question “What is the rate of change of the vole population right at time $t = 0$ ”, what would your answer be?
2. For the same vole population as above, estimate the rate of change of the vole population (in voles per month) at time $t = 12$ (i.e. one year past $t = 0$).
3. The water height at an ocean beach is given by $H = 2.5 \sin(4\pi t)$ where H is measured in meters and t is measured in days.

- a) Sketch the graph of this curve over the time interval $t = 0$ to $t = 2$, i.e. over the first two days. Make a nice, large, tidy, readable graph. Be sure to label the axes and put some appropriate ticks on them.
- b) How many high tides per day are there? On your graph, mark all the high tides that occur over the first day (i.e. between time $t = 0$ and $t = 1$).
- c) What is the average rate of change of the water height over the time period $t = 0$ and $t = 1$? What are the units of your answer?
- d) What is the average rate of change of the water height over the time period $t = 0$ and $t = .5$? What are the units of your answer?
- e) What is the average rate of change of the water height over the time period $t = 0$ and $t = 1/8$? What are the units of your answer?
- f) On your graph, sketch a secant line that has the same slope as your answer for the previous problem.
- g) What is the average rate of change of the water height over the first hour?
- h) What is the average rate of change of the water height over the first minute?
- i) How fast is the water rising at time $t = 0$?
- j) How fast is the water rising at time $t = 1/8$?