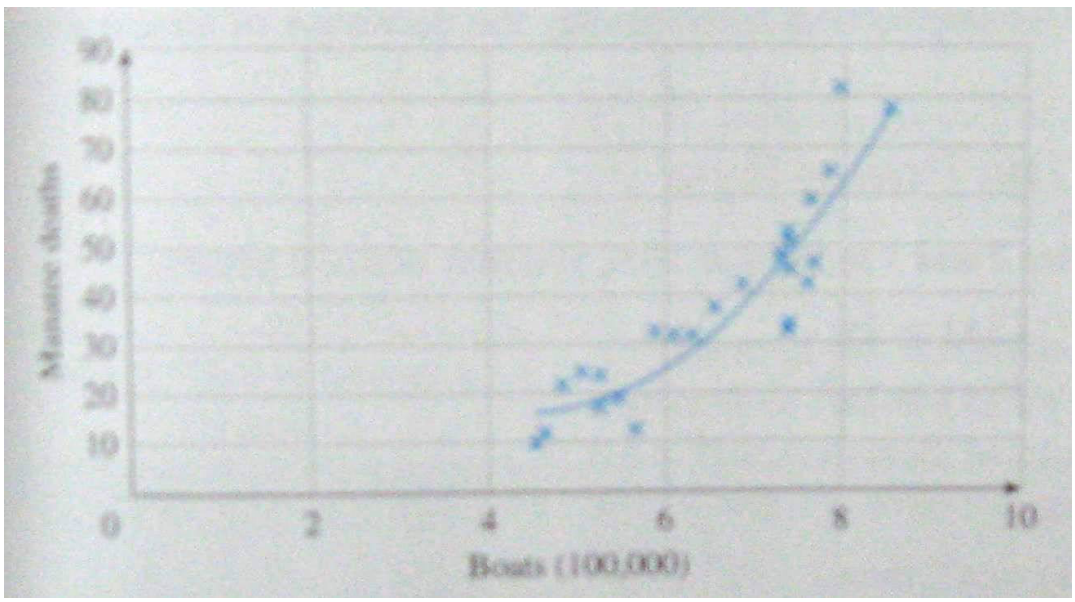
ALES 291/Math 120 **Assignment 6** Due: 4 pm February 28

1. (*5 marks*) **Manatees** Increasing numbers of manatees are being killed in collisions with boats off the coast of Florida. The relationship between the number of boat registrations and the number of manatees killed each year can be modeled by the function

$$f(x) = 3.55x^2 - 30.2x + 81$$

for $4.5 < x < 8.5$ where $f(x)$ is the number of manatee deaths and x is the number of registered boats (in hundreds of thousands). (I apologize for the blurriness of the graph in the image below. I only included it to give you an idea of the data the model is based on.)



a) What is the rate of change in manatee deaths when there are 500,000 boat registrations?

b) What is the rate of change in manatee deaths when there are 800,000 boat registrations?

2. (*10 marks*) **Turkey embryos** The oxygen consumption of a turkey embryo changes from the time the egg is laid until the time the turkey chick hatches. In a brush turkey the oxygen consumption (in millilitres per hour) can be modeled by

$$c(t) = -0.0012t^3 + 0.12t^2 - 1.83t + 3.97$$

where t is the time in days since the egg was laid (turkey chicks usually hatch around day 50).

a) Is the oxygen consumption increasing or decreasing on day 5? At what rate?

b) Is the oxygen consumption increasing or decreasing on day 20? At what rate?

c) When between days 0 and 50 is the oxygen consumption increasing at the fastest rate? What is that rate of increase?

3. (*10 marks*) **Penicillin absorption** The concentration of penicillin in the blood (in μg/mL) varies with time (t in hours) according to the relationship,

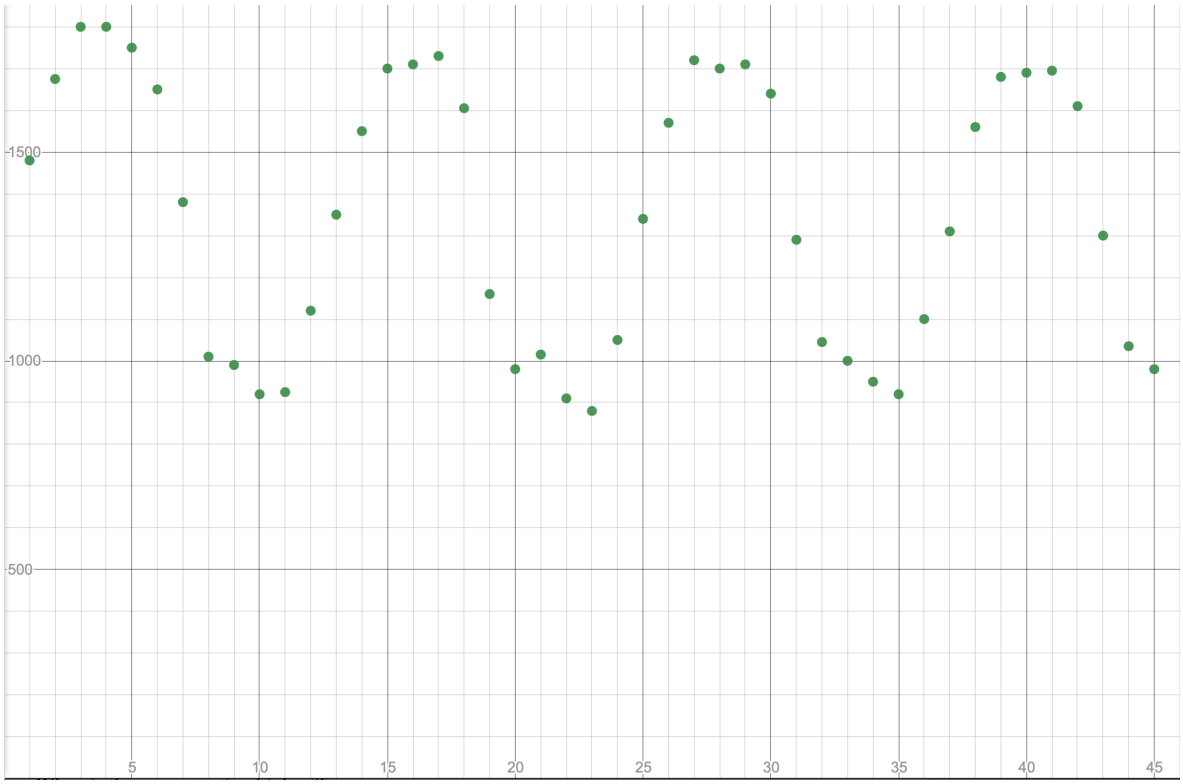
$$c(t) = 5e^{-0.2t} - 5e^{-0.3t}$$

a) What is the rate of absorption at time t=1?

b) What is the rate of absorption at time t=8?

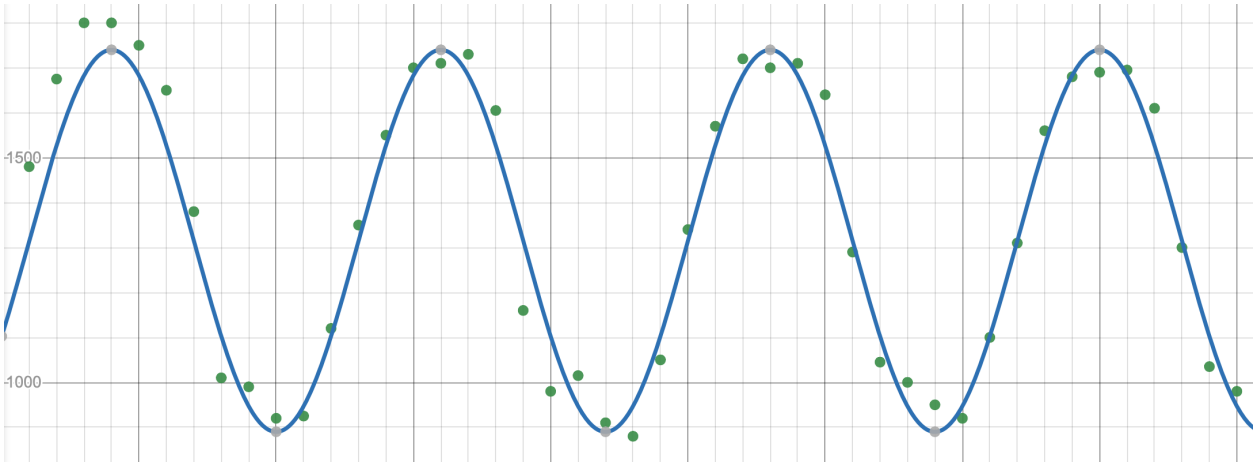
c) When is the concentration of penicillin highest?

4. (*10 marks*) **Employment benefits** In pre-Covid times Yukon employment patterns were surprisingly predictable. Here's the number of people receiving employment benefits over one not-quite four-year period.



The data can be fit quite closely by the equation,

$$y = 425 \sin\left(\frac{2\pi}{12}(x-1)\right) + 1315$$



a) What is the rate of change of claims at month 5? At month 22? At month 11.5?

b) At what time of year (by month numbers) are benefit claims rising fastest? Falling most quickly? What is the relation between these two times?

c) What is the average number of claims at any given time?[1]

5. (*5 marks*) **Find** $\frac{d^{99}}{dx^{99}}[\sin x]$, i.e. the 99th derivative of sin*x*.

[1] Hint: No calculus required, just a glance at the equation.