

Name:
Section:

Date:

Math130: Biomodule 5

You must show all work and give units for your answers to receive full credit.

Antarctic krill (*Euphausia superba*), a widespread species with circumpolar distribution, is central to the Antarctic marine food web, as most organisms are either direct predators of krill or are just one trophic level removed. Krill are tightly coupled with the marginal ice-edge zone to forage on sea ice algae in summer and winter, and juvenile krill rely on under ice habitat for overwintering and as a refuge from predators.

1) Ocean productivity is usually measured as Chlorophyll-a concentration since Chlorophyll-a is a good proxy for the amount of algae present in the water. Chlorophyll-a concentration depends on the extent of sea ice during the winter, and we can use the following equation to describe this relationship:

$$C(i) = 5i^2 + 10$$

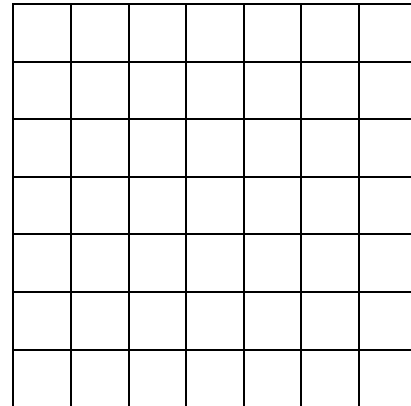
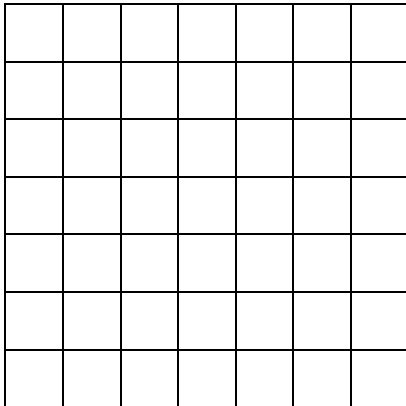
At the same time, krill density depends on ocean productivity, and this relationship is described by the following equation:

$$K(i) = (C(i))^{0.8}$$

Krill density, in this case, is measured as kilograms of krill per season.

a) Write the function for the instantaneous rate of increase of krill density. (1pt)

b) Graph the equation for the relationship between sea ice extent and krill density, then graph the first derivative of the function. (Graph in the domain $i \in [0,35]$ using 5 unit intervals. Make sure to label axes and units.) (2pts)



c) Does this function (not the derivative) have a minimum or maximum? If so, which, and for what value of i ? (2pts)

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2. Areas of the highest krill concentration are often close to the land-based breeding colonies of penguins. These colonies depend on nearby krill populations to feed and rear their offspring during the Antarctic summer.

a) Krill is the basic diet of Adélie penguins (*Pygoscelis adeliae*). A colony of about 25000 individuals catch approximately 28.5 metric tons of krill per day during the breeding season, which lasts around 90 days. (1 metric ton = 1000 kg). Write a function relating krill density and penguin feeding to find the maximum size of a colony. (Hint: start by determining how many kg of krill are required for each penguin per day.) Make sure to define your variables. (1pts)

3) As the breeding season progresses, penguin progenitors have to devote a larger proportion of their catch to feed their chicks, until they fledge and are able to feed by themselves. The following equation describes the percentage of their catch devoted to the chicks, $P(t)$, based upon the time since hatching, t .

$$P(t) = \frac{100t^2}{(200 + t^2)}$$

a) Find the function for the rate of change in the feeding behavior of the penguin parents. (2pt)

b) Do you think $P(t)$ adequately describes penguin feeding behavior over the course of a penguin's life? Explain your answer based on the equation given. (2pts)