Homework Nine

Calculus I

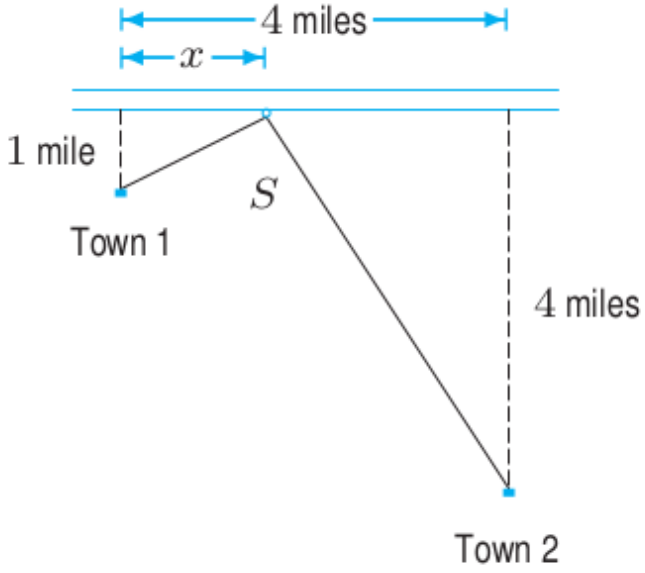
College of the Atlantic

Due Friday, November 15, 2024

Part 1: WeBWorK. The is no WeBWorK this week!!
Part 2: Non-WeBWorK problems. Here are some instructions for how to submit this part of the assignment.

- Do the problems by hand using pencil (or pen) and paper. There is no need to type this assignment.
- Make a pdf scan of your work using genius scan or some similar scanning app. Please make the homework into a single pdf, not multiple pdfs.
- Submit the assignment on google classroom. Please don't email it to me.

Here are some non-WeBWorK problems.



1. Two towns are located near a straight river, as shown in the figure above. Town 1 is one mile from the river and town 2 is four miles from the river. The two towns both will get drinking water from a single pumping station, whose location is indicated by S on the figure. There will need to be a pipeline from the pumping station to each of the towns. Where should the pumping station be located so the length of the pipeline is minimized?

2. A bird gathers worms to feed to its young. To do so, it flies from its nest to wherever the worms are, picks up several worms in its beak, and then returns to its nest to feed its hungry children. A *loading curve*, such as the one shown in Fig. 1, shows how the number of worms the bird picks up depends on the time the bird spends searching.

   (a) Why might the shape of the curve be concave down?

   (b) The time it takes the bird to travel from its next to the worm-gathering place is represented by the distance PO in Fig. 1. The birds (and its young) want to maximize the rate it which it brings worms to the next. This quantity is given by:

$$\text{Rate Worms Arrive} = \frac{\text{Number of Worms}}{\text{Traveling time} + \text{Searching time}} . \qquad (1)$$

   (c) Draw a line on Fig. 1 whose slope is equal to the rate at which worms arrive.

   (d) Using the figure, estimate the load (number of worms) which maximizes the worm arrival rate.

   (e) If the traveling time is increased, does the optimal load increase or decrease? Why?

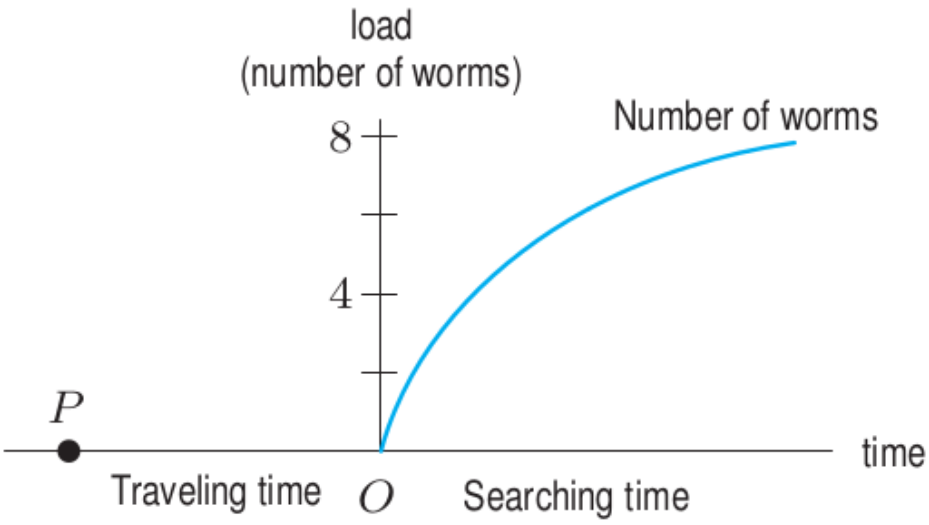


Figure 1: The load curve for the worm-gathering bird.

3. The cost of fuel (in dollars per hour) needed to move a boat through the water is proportional to the cube of the speed. (This means that $C = kv^3$.) A ferry boat uses \$100 of fuel per hour if it is cruising at 10 km per hour. The fuel isn't the only cost for the ferry. You also need to pay the crew. This cost comes to \$675 per hour. At what speed should the ferry travel so as to minimize the cost per kilometer traveled?