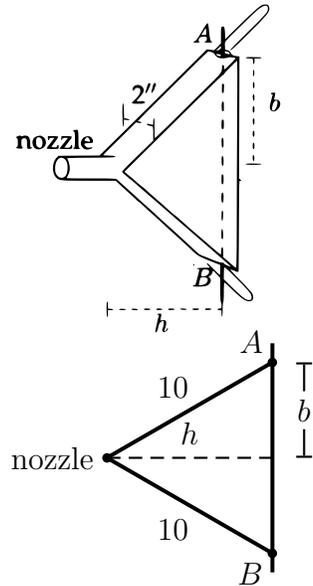


Worksheet To Infinity, and Beyond

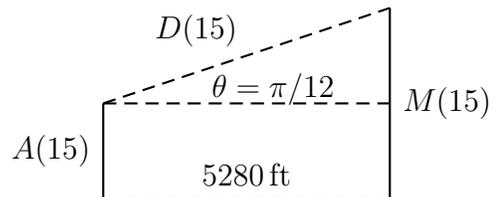
1. (This problem appeared on a Winter, 2008 Math 115 exam) A bellows has a triangular frame made of three rigid pieces. Two pieces, each 10 inches long, are hinged at the nozzle. They are attached to the third piece at points A and B which can slide, as shown in the diagrams below. (The figures show a 3D sketch of the bellows and a 2D sketch that may be specifically useful to solve the problem.)

Each piece of the frame is 2 inches wide, so the volume (in cubic inches) of air inside the bellows is equal to the area (in square inches) of the triangular cross-section above, times 2. Suppose you pump the bellows by moving A downward toward the center at a constant speed of 3 in/sec. (So B moves upwards at the same speed.) What is the rate at which air is being pumped out when A and B are 12 inches apart? (So A is 6 inches from the center of the vertical piece of the frame.)



2. (Adapted from a Fall, 2011 Math 115 Final Exam problem) Alec takes the train home to South Dakota. At one point during the trip the tracks run parallel to a road, which is a mile away. The train is going quite slowly (6 ft/sec). Alec spots a Maserati sports car even with the train on the road, and turns his head as he watches it pull ahead. Let $M(t)$ be the distance between the car and its starting point, and $A(t)$ be Alec's distance from his starting point. After watching the car for 15 seconds, Alec has rotated his head $\pi/12$ radians.

- (a) Initially the car is 1 mile (5280 ft) due east of the train. Find the distance between Alec and the car 15 seconds after he starts watching it.



- (b) Let $\theta(t)$ be the angle Alec has turned his head after tracking the car for t seconds. Write an equation for the distance between Alec and the car at time t . (Your answer may involve $\theta(t)$.)
- (c) If at precisely 15 seconds, Alec is turning his head at a rate of .01 radians per second, what is the instantaneous rate of change of the distance between Alec and the car?
- (d) What is the speed of the car at 15 seconds?

3. (Fall, 2009) After an unusual winter storm, the EPA is concerned about potential contamination of a river. A new researcher has been assigned the task of taking a sample to test the water quality. She tried to get as close to the river as possible in her car, but was forced to park a feet away. She also cannot get closer to the lab by car. She needs to walk to the river, retrieve a water sample, and then walk the sample to a lab located $4a$ feet down the river and $2a$ feet from the river bank. If the researcher wants to walk as short a distance as possible, what path should she take as she walks from her car to the river and then from the river to the lab?