1. The rate of change of atmospheric pressure P with respect to altitude h is proportional to P. (This assumes the temperature is constant; let us assume that.)

(a) Write a differential equation corresponding to the first sentence above; use k for the constant of proportionality. Then write a formula for $P(h)$ in terms of $P(0)$, k, and h.

(b) At a temperature of $15\,^{\circ}C$, the pressure is 101.3 kPa at sea level and the pressure is 87.14 kPa at $h = 1000$ m. From these facts, determine $P(0)$ and k.

(c) What is the pressure at the top of Denali, at an altitude of 6187 m? (*The problem in the book, #19 in §3.8, has an error. It calls it "Mount McKinley."*)

(d) At what altitude is the pressure $1/3$ of what it is at sea level?

2. Gravel can be made by crushing rock and then running it through a screen for sorting. Typically the sorted gravel is piled into a cone by a conveyor belt. Because the gravel slides down the sides as the pile steepens, the sides alway have about the same angle (the *angle of repose*) and the pile keeps its shape as it grows.

(a) Draw a conveyor belt feeding a conical pile of gravel. Label the radius of the base of the cone as r and its height as h.

(b) The volume of a cone is

$$V = \frac{1}{3}\pi r^2 h.$$

As the pile grows, which of the variables in this equation depend on time?

(c) Compute dV/dt by differentiating the above equation, keeping in mind that the other variables are also functions of time.

(d) If the conveyor belt is adding $5\,\mathrm{m}^3$/min of gravel to the pile, and the angle of the sides of the pile is 40°, at what rate is the height increasing when the base has radius 20 m?