Project: Dives with Stops and Tissue k-Values.

Prerequisites: Completion of Section 2.3 of *Differential Equations: Techniques, Theory, and Applications* by MacCluer, Bourdon, and Kriete.

In scuba diving, we have seen that for bounce-dives only the tissue with the largest k-value (or shortest half-time) needs to be considered for determining maximal time at depth. For dives with stops, the situation is more complicated. Brian Hills, Chief of the Hyperbaric Physiology Section at the University of Texas Medical Branch in Galveston, writes "...'fast' tissues with large initial gas uptake tend to control early phases of decompression, while the 'slow' tissues, with less uptake, but a lower rate of elimination, determine the later stops."[1] The purpose of this project is to explore this principle.

A diver descends instantaneously to a depth of 110 feet and spends 130 minutes at this depth. We will consider three tissue half-times of 5 minutes, 20 minutes, and 75 minutes (see Exercise 13 in Section 2.3 for how to convert half-times to k-values) and assume instantaneous ascent for each of the stops.

(a) What is the pressure in each of these three tissues after 130 minutes? Show that it is safe to ascend to 40 feet.

(b) The first decompression stop is planned at 40 feet for 20 minutes. Compute the pressure in each of the three tissues at the end of this stop. Which tissue has the highest pressure? Is it safe to ascend to 30 feet?

(c) The next stop is planned for 50 minutes at 30 feet. Compute the pressure in each tissue at the end of this stop. Which tissue has the highest pressure? Is it safe to ascend to 10 feet?

(d) The final stop at 10 feet is to be 50 minutes. Are all pressures below 2.2 atm at the end of this time? Which tissue has the highest pressure?

(e) Does this example illustrate Hills' principle as described above? Explain.

[1] B. A. Hills, *Decompression Sickness*, Vol. 1, Wiley-Interscience, Chichester, 1977, p. 112.