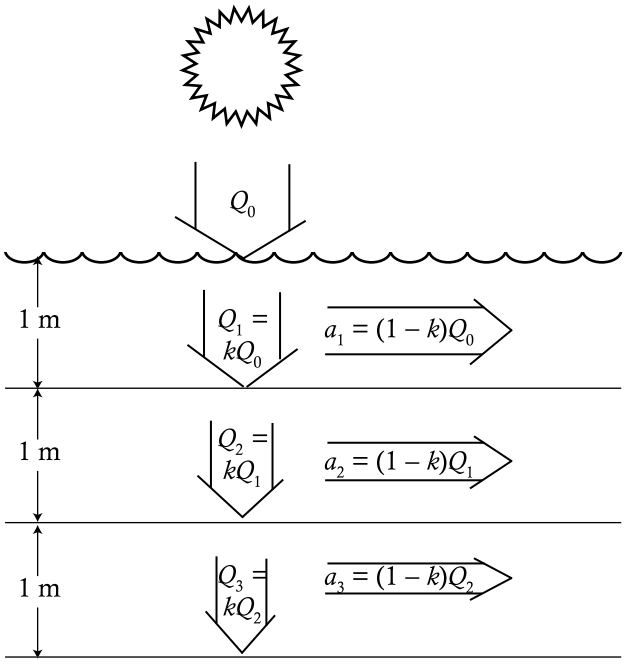
Exercise 2

A model of how deeply solar radiation penetrates into an ocean or lake can be made by assuming a certain transmission fraction (k) passes through each meter of depth. Thus, if Q_0 is the amount of insolation entering the top of the water column, then $Q_1 = kQ_0$ is how much there is left at one meter down, $Q_2 = kQ_1 = k^2Q_0$ is how much there is left at two meters down, and so on: $Q_j = kQ_{j-1} = \ldots = k^jQ_0$. To program this for a model, where Q_0 is known, we use the recursive part of the equation:

$$Q_j = k \times Q_{j-1}$$

The energy that is *not* transmitted through each layer is absorbed in that layer to warm it up. (That is conservation of energy in simple form: the solar radiation must be either absorbed into heat or passed along.) So the energy absorbed into the first one-meter-thick layer is $a_1 = (1-k)Q_0$, the energy absorbed in the second layer is $a_2 = (1-k)Q_1 = (1-k)kQ_0$, and in general:

$$a_j = (1-k) \times Q_{j-1}$$



Write a program that prints a table to the screen of transmitted (Q) and absorbed (a) radiation at each of the first 20 one-meter-thick layers of the ocean. To simplify this, you may set the starting point at an incident $Q_0 = 100$ so that results are expressed as a percentage of net surface (bottom-of-atmosphere) downwelling shortwave radiation. The value of k varies with sun angle and turbidity of the water, so you should start by asking the user to input a value of k and reading that value from the keyboard.

To assist in debugging your program, the value of a in the 20th layer will be 0.034, 0.288, and 1.351 for values of $k = 0.7$, 0.8, and 0.9, respectively. Solving this problem without a `DO` loop (such as by using the editor to copy some lines of code many times and edit them) is *not acceptable*. You will be working on this table before we get to formatting output, so you may use default formatting and have uneven columns for this exercise. (10 points)

For further thought: This model does not include backscattering, in which some shortwave radiation enters each layer by scattering from below. There should be an additional reflection parameter, r, which takes some fraction of the kQ_{j-1} and sends it back to layer $j-1$. That is a small effect for an ocean, and was left out to make this program simple enough for a first programming exercise.