1. TREE

   (a) A tree falls across a canal of depth $3.6\,\mathrm{m}$. Estimate on the basis of linear shallow-water wave theory how long it will take for the disturbance to be felt at a distance of $100\,\mathrm{m}$ along the canal?

   (b) What will be the difference if there is a mean flow in the canal of (i) $3\,\mathrm{ms}^{-1}$ and (ii) $6\,\mathrm{ms}^{-1}$?

2. LAKE

   (a) A long narrow lake is $10\,\mathrm{m}$ deep and $10\,\mathrm{km}$ long. On the basis of shallow-water theory (for $f = 0$) estimate the characteristic period(s) of seiches in the lake?

   (b) A similarly shaped lagoon, open to the ocean at one end, has characteristic period commensurate with the main ocean tide. What is the length of the lagoon, and what kind of flow response can be anticipated?

3. LINEAR SHALLOW-WATER SYSTEM

   Verify that the linear shallow-water-system

   $$\begin{aligned} u'_t - fv' &= -gh'_x \\ v'_t + fu' &= -gh'_y \\ h'_t + H(u'_x + v'_y) &= 0 \end{aligned}$$

   has a solution (valid in the domain $y > 0$) of the form:

   $$\begin{aligned} v' &= 0 \\ h' &= A\sin[k(x - ct)]e^{-\mu y} \end{aligned}$$

   (a) Find the phase speed c and the decay rate $1/\mu$ as a function of H, g and f.

   (b) Determine the phase speed c and the decay rate $1/\mu$ for $H \sim 10\,\mathrm{m}$ and $f \sim 10^{-4}\,\mathrm{s}^{-1}$.

   (c) What would be the maximal velocity u' under the assumed values of (b).