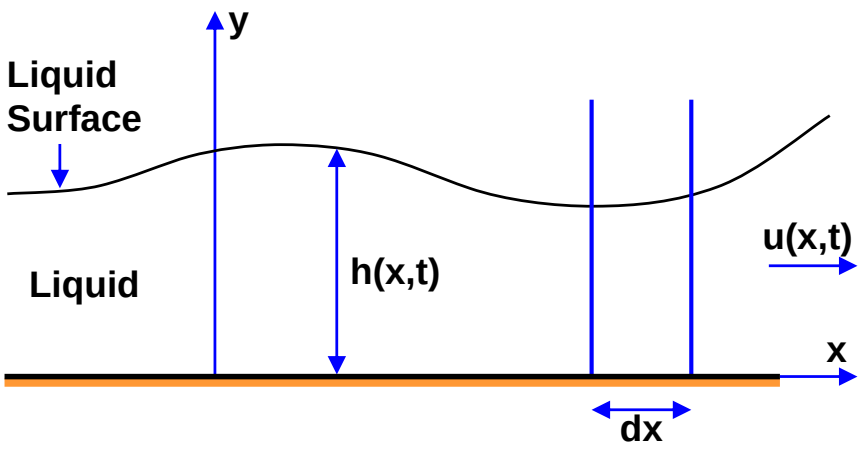
Problem 113A

Construct from first principles an equation for the conservation of mass which governs the planar flow (in the xy plane) of an incompressible liquid lying on a flat horizontal plane:



The depth, $h(x,t)$, is a function of x and time, t. Examine an Eulerian element of width, dx, as shown above (it extends from $y = 0$ to $y = \infty$) and assume that the velocity, $u(x,t)$, of the water in the positive x direction is **independent of** y. Then utilize conservation of mass to obtain a partial differential equation connecting the depth, $h(x,t)$, and the velocity, $u(x,t)$. Neglect surface tension. [This is one of the equations of what is known as "shallow water wave theory".]