Problem 1.

The gap between a plane moving block and a stationary wall of height $H$ is filled with a liquid of density $\rho$. At time $t = 0$, the gap width is $b_0$. The speed $U$ of the moving wall is constant. The direction of gravity is shown. Assume that $\mathbf{P} = 0$ at $z = H$ and that $\rho$ is constant. Assume that the flow is two-dimensional with velocity components $u$ and $w$ in the $x$ and $z$ directions respectively. There is no motion perpendicular to the plane of the drawing.

I. First, assume that the flow is inviscid.

a). Assume that the velocity profile $w$ is uniform. Find $w$ in the gap in terms of $U, z$, and $b$.

b). What is $\mathbf{P}$ in the gap at an arbitrary height $z < H$.

c). What is $\frac{\partial u}{\partial t}$ in the gap at an arbitrary height $z < H$?

II. Now, assume that the flow is not inviscid.

d). How would the quantities $w$, $\mathbf{P}$, and $u$ in the gap change, and why? You are not expected to obtain a full solution for the fluid motion. Instead, use discussion, equations, and drawings as appropriate to aid in your answer.
Problem 2.

A cylindrical container with length $L$ and diameter $D$ ($D$ and $L$ have the same order of magnitude) contains Fluid 1 with density $\rho_1$. The top and bottom of the cylinder are removed, and Fluid 1 is allowed to interact with the surrounding Fluid 2 which has density $\rho_2$, where $\rho_1 > \rho_2$. A large round plate is located a distance $10L$ below the cylinder. Assume that both fluids are incompressible.

Describe the resulting flow. Use drawings and equations to aid in your description.