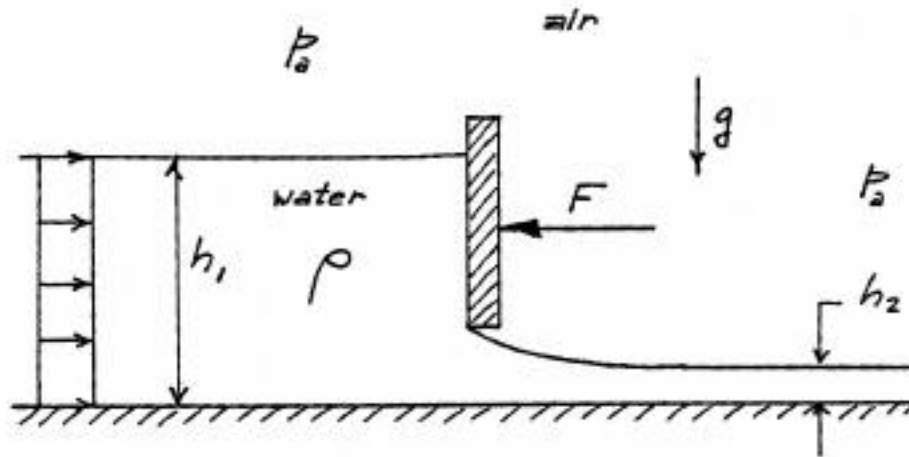# Problem 5.3

Force on sluice gate

Sluice gates are used to regulate water level (or flow rate) in open channels. The figure shows a gate that is adjusted so that the upstream depth is maintained at a depth h_1. The density of water is ρ, and the acceleration of gravity is g. The water flow under the gate may be considered incompressible and inviscid.

Suppose the downstream depth is measured as h_2, that is, the quantities h_1, h_2, ρ, *and* g are known.

(a) Assuming uniform velocities at the far upstream and downstream stations 1 and 2 derive an expression for the horizontal force F, per unit breadth, required to hold the gate in place. Check your result by showing that it gives zero when $h_1 = h_2$ and the hydrostatic result $\rho g h_1^2 /2$ when $h_2 = 0$.

HINT   HINT 2   HINT 3   ANSWER

(b) Also obtain expressions for the velocities V_1 and V_2 and the volume flow rate Q per unit breadth in the stream. Show that as h_2 approaches zero, V_2 approaches $\sqrt{2gh_1}$. Explain.

HINT   ANSWER