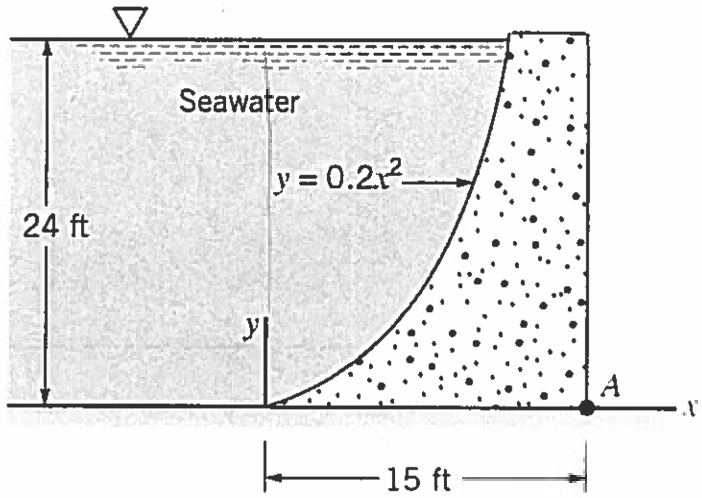
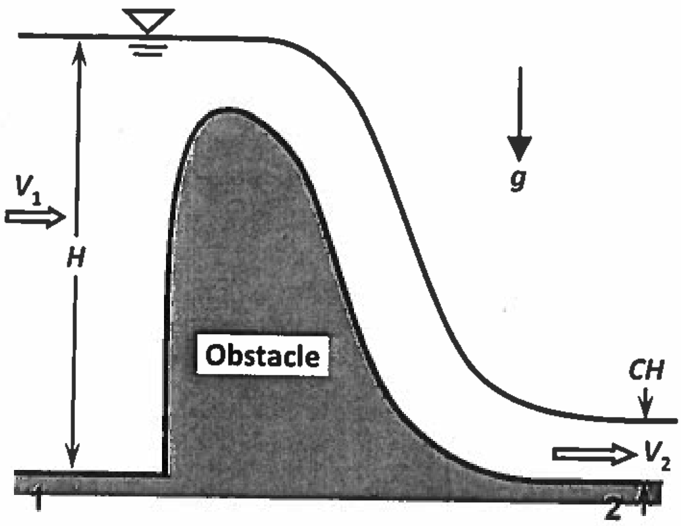
1. The curved concrete seawall shown in the figure has a specific weight of 150 lb/ft^3. The equation for the curved surface is given in the figure.

a) Determine the moment of the fluid force (per unit length) with respect to the axis through point A if the water level is 24 ft.
b) Assuming that the concrete block is not attached at the base, is there a critical water height, y_c, where for $y > y_c$ the concrete wall will tip over around the axis through point A? (assume the height of the block and the water level are always the same and the equation for the wall curvature applies for any *possible* height).



2. The power P required by a centrifugal pump is a function of discharge Q, head H, gravitational acceleration g, fluid viscosity μ, fluid density ρ, speed of rotation N, and impeller diameter D. The pump was tested in the laboratory using a 1:8 scale geometrically similar model. The model uses a liquid with the same density as the prototype. The model consumes 5 kW of power working at 5 m head, 450 rpm speed and 1 m^3/s discharge. If the prototype is to work under 80 m head, determine its power requirement, speed, and the discharge. Determine the viscosity ratio of the model and prototype liquids.

3. The water (density ρ) in a channel has a depth H at Section 1, and flows over a large obstacle. The water has a depth of CH (where the known constant $C < 1$) some distance past the obstacle at Section 2. You may assume that viscous effects are negligible.



The known parameters in this problem are ρ, H, C, g

Define your control volume and list all additional assumptions

a) Determine the speed of the flow upstream of the obstacle V_1 and the speed of the flow downstream of the obstacle V_2.

b) Find the force per unit dimension normal to the page $\vec{\mathbf{F}}$ exerted by the flow on the obstacle.

4. Consider a long, flat plate that is moving vertically upward out of a liquid bath (density ρ and viscosity μ) with constant velocity U_o in ambient (atmospheric) air as shown in the figure. Sufficiently far from the plate's leading edge and from the free surface of the bath, the liquid forms a film of thickness h on each side of the plate as a result of the balance between gravity and the movement of the plate.

   You may assume that (sufficiently far below the plate's leading edge and above the surface of the liquid bath) the laminar steady flow within the film is fully-developed and uniform across the span of the plate (in the z direction) with zero pressure gradient, and that the shear at the ambient air interface is negligible.

   Using a small element of fluid that is bounded on one side by the surface of the plate $y = 0$, as shown in the figure:

   a) Write an equation that describes the balance of forces on the fluid element (sketch all the relevant forces).
   b) Determine the appropriate velocity boundary conditions at $y = 0$ and $y = h$.
   c) Calculate the velocity distribution within the film.
   d) Determine the volume flow rate Q of the fluid that is moved up by the plate in terms of U_o, ρ, μ, g and h.