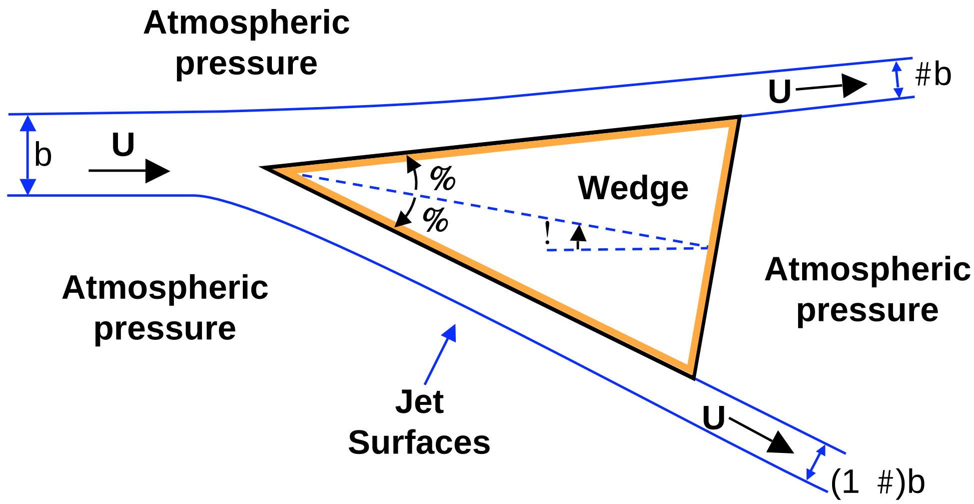
Problem 220E

A wedge with a vertex angle of 2θ is inserted into a jet of water (density, ρ) of width, b, and velocity, U, as shown in the sketch below.



The angle of attack, α, of the wedge is also defined in the sketch. The result is that the single incident jet is divided into two jets both of which leave the back edges of the wedge with the velocity, U. The widths of the two departing jets are βb and $(1-\beta)b$ as indicated in the figure. It is assumed that the flow is planar and that the pressure in surrounding air is everywhere atmospheric.

1. Find the lift and drag on the wedge per unit length normal to the sketch as functions of ρ, U, b, β, α and θ. Note that drag and lift are defined as the forces on the wedge which are respectively parallel to and perpendicular to the direction of the incident jet.

2. If the angle of attack, α, is varied while ρ, U, b, β and θ remain fixed, find the angle of attack at which the lift is zero.

3. If, on the other hand, the wedge is moved in a direction perpendicular to the incident jet while ρ, b, U, θ and α remain fixed then β will change. There is one such position at which the lift is zero; what is the value of β at this position in terms of θ and α ? If the wedge were free to move in such a way would this position represent a position of stable or unstable equilibrium?