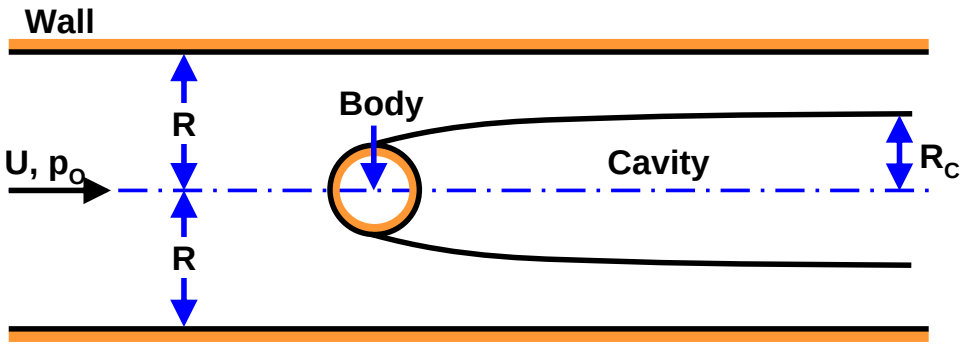
Problem 220D

An axisymmetric body (a sphere if you wish) is mounted in a water tunnel which has a circular cross-section of radius, R. The velocity far upstream, U, is fixed. When the pressure far upstream, p_o, is lowered sufficiently a large vapor-filled wake or cavity forms behind the body:



The pressure in the cavity is simply given by the vapor pressure, p_v, of the water at the operating water temperature ($p_o > p_v$). It is to be assumed that the effect of friction, the effect of gravity, the density of the vapor and the amount of water vaporized at the free surface are all negligible. A parameter called the cavitation number, σ, is defined as

$$\sigma = \frac{p_o - p_v}{\frac{1}{2}\rho U^2}$$

where ρ is the water density.

(a) Find the relation between R_c/R and σ for very long cavities whose asymptotic radius is R_c.

(b) Find the drag on the body in terms of U, R, σ and ρ.