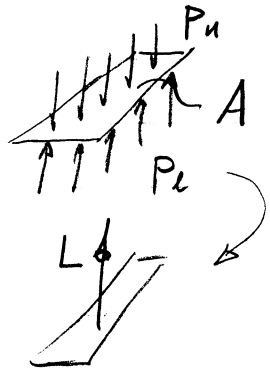
Problem F1 Solution UE Fall '07



a) Lift force = $p_l A - p_u A = \Delta p \cdot A$

where A = wing area

i.e. net force (Lift) is the difference between bottom and top pressure forces

In level flight, must have Lift = weight

or $\Delta p \cdot A = W \rightarrow \boxed{\Delta p = \frac{W}{A} = \frac{9\ lb}{420\ in^2} = 0.0214\ psi}$

b) From definition of C_p: $\frac{1}{2}\rho V^2 \Delta C_p = \Delta p \rightarrow V = \sqrt{\frac{2\Delta p}{\rho \Delta C_p}}$

Switch to SI units for convenience: $\Delta p = 0.0214\ psi = 147.8\ Pa$

At sea level: $\rho = 1.225\ kg/m^2$, so $\boxed{V = \sqrt{\frac{2 \cdot 147.8\ Pa}{1.225\ kg/m^3 \cdot 1}} = 15.53\ m/s = 34.6\ mph}$

At 15000 ft: $\rho = 0.770\ kg/m^2$, so $\boxed{V = \sqrt{\frac{2 \cdot 147.8\ Pa}{0.770\ kg/m^3 \cdot 1}} = 19.59\ m/s = 43.6\ mph}$

ρ values obtained from Anderson, App D.