9.93

9.93 A Boeing 747 aircraft weighing 580,000 lb when loaded with fuel and 100 passengers takes off with an airspeed of 140 mph. With the same configuration (i.e., angle of attack, flap settings, etc.) what is its takeoff speed if it is loaded with 372 passengers. Assume each passenger with luggage weighs 200 lb.

For steady flight $\mathcal{L} = C_L \frac{1}{2}\rho V^2 A = W$ (1)

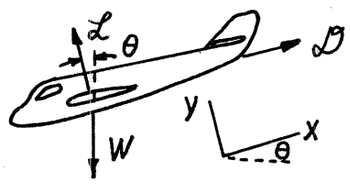
Let $(\ )_{100}$ denote conditions with 100 passengers and $(\ )_{372}$ with 372 passengers. Thus, with $C_{L_{100}} = C_{L_{372}}$, $A_{100} = A_{372}$, and $\rho_{100} = \rho_{372}$ Eq. (1) gives

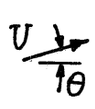
$$\frac{\mathcal{L}_{100}}{\mathcal{L}_{372}} = \frac{V_{100}^2}{V_{372}^2} \quad \text{or} \quad V_{372} = V_{100}\left\{\frac{[580{,}000 + (372-100)(200)]\,\text{lb}}{580{,}000\,\text{lb}}\right\}^{1/2}, \text{ with } V_{100} = 140 \text{ mph}$$

Thus, $V_{372} = \underline{\underline{146 \text{ mph}}}$

9.94

9.94 Show that for unpowered flight (for which the lift, drag, and weight forces are in equilibrium) the glide slope angle, θ, is given by $\tan\theta = C_D/C_L$.





For steady unpowered flight

$\Sigma F_x = 0$ gives $\mathcal{D} = W\sin\theta$

and

$\Sigma F_y = 0$ gives $\mathcal{L} = W\cos\theta$

Thus,

$$\frac{\mathcal{D}}{\mathcal{L}} = \frac{W\sin\theta}{W\cos\theta} = \tan\theta, \text{ where } \frac{\mathcal{D}}{\mathcal{L}} = \frac{\frac{1}{2}\rho V^2 A C_D}{\frac{1}{2}\rho V^2 A C_L} = \frac{C_D}{C_L}$$

Hence, $\underline{\underline{\tan\theta = \frac{C_D}{C_L}}}$