

67. **REASONING** In level flight the lift force must balance the plane's weight W , so its magnitude is also W . The lift force arises because the pressure P_B beneath the wings is greater than the pressure P_T on top of the wings. The lift force, then, is the pressure difference times the effective wing surface area A , so that $W = (P_B - P_T)A$. The area is given, and we can determine the pressure difference by using Bernoulli's equation.

SOLUTION According to Bernoulli's equation, we have

$$P_B + \frac{1}{2}\rho v_B^2 + \rho g y_B = P_T + \frac{1}{2}\rho v_T^2 + \rho g y_T$$

Since the flight is level, the height is constant and $y_B = y_T$, where we assume that the wing thickness may be ignored. Then, Bernoulli's equation simplifies and may be rearranged as follows:

$$P_B + \frac{1}{2}\rho v_B^2 = P_T + \frac{1}{2}\rho v_T^2 \quad \text{or} \quad P_B - P_T = \frac{1}{2}\rho v_T^2 - \frac{1}{2}\rho v_B^2$$

Recognizing that $W = (P_B - P_T)A$, we can substitute for the pressure difference from Bernoulli's equation to show that

$$\begin{aligned} W &= (P_B - P_T)A = \frac{1}{2}\rho(v_T^2 - v_B^2)A \\ &= \frac{1}{2}(1.29 \text{ kg/m}^3)\left[(62.0 \text{ m/s})^2 - (54.0 \text{ m/s})^2\right](16 \text{ m}^2) = \boxed{9600 \text{ N}} \end{aligned}$$

We have used a value of 1.29 kg/m^3 from Table 11.1 for the density of air. This is an approximation, since the density of air decreases with increasing altitude above sea level.