

48. The lift force follows from the pressure difference (large pressure on the bottom surface than on the top) and the fact that the pressure difference is related to force through the relation  $\Delta p = F/A$  where we are asked to use  $L$  for  $F$ . From Bernoulli's equation, we have

$$p_u - p_t = \frac{1}{2}\rho v_t^2 - \frac{1}{2}\rho v_u^2 + \rho g \Delta z$$

where  $\Delta z$  is the thickness of the wing. The last term makes a negligible contribution (we will return to this point in a moment) and can be ignored. We then have

$$\Delta p = \frac{1}{2}\rho (v_t^2 - v_u^2) \implies L = \frac{1}{2}\rho A (v_t^2 - v_u^2)$$

as desired. The contribution of the “potential” term would have been  $\rho g A \Delta z$  which we can estimate as follows: let  $\rho \approx 1 \text{ kg/m}^3$ ,  $A \approx 100 \text{ m}^2$ , and  $\Delta z \approx 1 \text{ m}$ . Then  $\rho g A \Delta z \approx 1000 \text{ N}$  which perhaps corresponds to the weight of a couple of adults, and is at least an order of magnitude less than the weight of an airplane with wings (the size of which are as estimated above) and equipment and crew.