Chapter 3 Problem 98 †

Given
$a = 5.0\ m/s^2$
$\Delta x = 10.0\ km = 10,000\ m$
$t = 30.0\ s$

Solution
What are the initial and final velocities of the airplane?

Since the airplane has a constant acceleration, we can use the kinematic equations. Since we know the time and the acceleration, we can use the first kinematic equation.

$$v_f = v_0 + at$$

$$v_f = v_0 + (5.0\ m/s^2)(30.0\ s) = v_0 + 150.0\ m/s \qquad (eq.1)$$

Now use the third kinematic equation and substitute in the know values

$$x - x_0 = v_0 t + \tfrac{1}{2}at^2$$

$$10,000\ m = v_0(30.0\ s) + \tfrac{1}{2}(5.0\ m/s^2)(30.0\ s)^2$$
$$10,000\ m = v_0(30.0\ s) + 2,250\ m$$

With algebra we get

$$7,750\ m = v_0(30.0\ s)$$

$$v_0 = \frac{7,750\ m}{30.0\ s} = 258.3\ m/s$$

Substitute this value into eq. 1 and the final velocity is

$$v_f = v_0 + 150.0\ m/s$$

$$v_f = 258.3\ m/s + 150.0\ m/s = 408.3\ m/s$$

The answers are only good to 2 sig. figs. Therefore, the initial velocity is 260 m/s and the final velocity is 410 m/s.

†Problem from University Physics by Ling, Sanny and Moebs (OpenStax)