SAMPLE PROBLEM D

Velocity and Displacement with Constant Acceleration

PROBLEM

A plane starting at rest at one end of a runway undergoes a uniform acceleration of 4.8 m/s^2 for 15 s before takeoff. What is its speed at takeoff? How long must the runway be for the plane to be able to take off?

SOLUTION

Given: $v_i = 0$ m/s $\quad a = 4.8$ m/s^2 $\quad \Delta t = 15$ s

Unknowns: $v_f = ?$ $\quad \Delta x = ?$

First, use the equation for the velocity of a uniformly accelerated object.

$$v_f = v_i + a\Delta t$$
$$v_f = 0 \text{ m/s} + (4.8 \text{ m/s}^2)(15 \text{ s})$$

$$\boxed{v_f = 72 \text{ m/s}}$$

Then, use the displacement equation that contains the given variables.

$$\Delta x = v_i \Delta t + \tfrac{1}{2} a (\Delta t)^2$$
$$\Delta x = (0 \text{ m/s})(15 \text{ s}) + \tfrac{1}{2}(4.8 \text{ m/s}^2)(15 \text{ s})^2$$

$$\boxed{\Delta x = 540 \text{ m}}$$

TIP

Because you now know v_f, you could also use the equation $\Delta x = \frac{1}{2}(v_i + v_f)(\Delta t)$, or $\Delta x = \frac{1}{2}(72 \text{ m/s})(15 \text{ s}) = 540 \text{ m}$.

PRACTICE D

Velocity and Displacement with Constant Acceleration

1. A car with an initial speed of 6.5 m/s accelerates at a uniform rate of 0.92 m/s^2 for 3.6 s. Find the final speed and the displacement of the car during this time.
2. An automobile with an initial speed of 4.30 m/s accelerates uniformly at the rate of 3.00 m/s^2. Find the final speed and the displacement after 5.00 s.
3. A car starts from rest and travels for 5.0 s with a constant acceleration of −1.5 m/s^2. What is the final velocity of the car? How far does the car travel in this time interval?
4. A driver of a car traveling at 15.0 m/s applies the brakes, causing a uniform acceleration of −2.0 m/s^2. How long does it take the car to accelerate to a final speed of 10.0 m/s? How far has the car moved during the braking period?