

Motion in One Dimension

Problem E**FINAL VELOCITY AFTER ANY DISPLACEMENT****PROBLEM**

In 1970, a rocket-powered car called *Blue Flame* achieved a maximum speed of 1.00×10^3 km/h (278 m/s). Suppose the magnitude of the car's constant acceleration is 5.56 m/s^2 . If the car is initially at rest, what is the distance traveled during its acceleration?

SOLUTION**1. DEFINE**

Given: $v_i = 0 \text{ m/s}$
 $v_f = 278 \text{ m/s}$
 $a = 5.56 \text{ m/s}^2$

Unknown: $\Delta x = ?$

2. PLAN Choose an equation(s) or situation: Use the equation for the final velocity after any displacement.

$$v_f^2 = v_i^2 + 2a\Delta x$$

Rearrange the equation(s) to isolate the unknown(s):

$$\Delta x = \frac{v_f^2 - v_i^2}{2a}$$

3. CALCULATE Substitute the values into the equation(s) and solve:

$$\Delta x = \frac{\left(278 \frac{\text{m}}{\text{s}}\right)^2 - \left(0 \frac{\text{m}}{\text{s}}\right)^2}{(2)\left(5.56 \frac{\text{m}}{\text{s}^2}\right)} = 6.95 \times 10^3 \text{ m}$$

4. EVALUATE Using the appropriate kinematic equation, the time of travel for *Blue Flame* is found to be 50.0 s. From this value for time the distance traveled during the acceleration is confirmed to be almost 7 km. Once the car reaches its maximum speed, it travels about 16.7 km/min.

ADDITIONAL PRACTICE

- In 1976, Kitty Hambleton of the United States drove a rocket-engine car to a maximum speed of 965 km/h. Suppose Kitty started at rest and underwent a constant acceleration with a magnitude of 4.0 m/s^2 . What distance would she have had to travel in order to reach the maximum speed?**
- With a cruising speed of 2.30×10^3 km/h, the French supersonic passenger jet Concorde is the fastest commercial airplane. Suppose the landing speed of the Concorde is 20.0 percent of the cruising speed. If the plane**

accelerates at -5.80 m/s^2 , how far does it travel between the time it lands and the time it comes to a complete stop?

3. The Boeing 747 can carry more than 560 passengers and has a maximum speed of about $9.70 \times 10^2 \text{ km/h}$. After takeoff, the plane takes a certain time to reach its maximum speed. Suppose the plane has a constant acceleration with a magnitude of 4.8 m/s^2 . What distance does the plane travel between the moment its speed is 50.0 percent of maximum and the moment its maximum speed is attained?
4. **The distance record for someone riding a motorcycle on its rear wheel without stopping is more than 320 km. Suppose the rider in this unusual situation travels with an initial speed of 8.0 m/s before speeding up. The rider then travels 40.0 m at a constant acceleration of 2.00 m/s^2 . What is the rider's speed after the acceleration?**
5. **The skid marks left by the decelerating jet-powered car *The Spirit of America* were 9.60 km long. If the car's acceleration was -2.00 m/s^2 , what was the car's initial velocity?**
6. The heaviest edible mushroom ever found (the so-called "chicken of the woods") had a mass of 45.4 kg . Suppose such a mushroom is attached to a rope and pulled horizontally along a smooth stretch of ground, so that it undergoes a constant acceleration of $+0.35 \text{ m/s}^2$. If the mushroom is initially at rest, what will its velocity be after it has been displaced $+64 \text{ m}$?
7. Bengt Norberg of Sweden drove his car 44.8 km in 60.0 min . The feature of this drive that is interesting is that he drove the car on two side wheels.
 - a. Calculate the car's average speed.
 - b. Suppose Norberg is moving forward at the speed calculated in (a). He then accelerates at a rate of -2.00 m/s^2 . After traveling 20.0 m , the car falls on all four wheels. What is the car's final speed while still traveling on two wheels?
8. **Starting at a certain speed, a bicyclist travels $2.00 \times 10^2 \text{ m}$. Suppose the bicyclist undergoes a constant acceleration of 1.20 m/s^2 . If the final speed is 25.0 m/s , what was the bicyclist's initial speed?**
9. **In 1994, Tony Lang of the United States rode his motorcycle a short distance of $4.0 \times 10^2 \text{ m}$ in the short interval of 11.5 s . He started from rest and crossed the finish line with a speed of about $2.50 \times 10^2 \text{ km/h}$. Find the magnitude of Lang's acceleration as he traveled the $4.0 \times 10^2 \text{ m}$ distance.**
10. The lightest car in the world was built in London and had a mass of less than 10 kg . Its maximum speed was 25.0 km/h . Suppose the driver of this vehicle applies the brakes while the car is moving at its maximum speed. The car stops after traveling 16.0 m . Calculate the car's acceleration.