Name:_____Class:_____ Date: _____

Motion in One Dimension

Problem D

VELOCITY AND DISPLACEMENT WITH CONSTANT ACCELERATION PROBLEM

A barge moving with a speed of 1.00 m/s increases speed uniformly, so that in 30.0 s it has traveled 60.2 m. What is the magnitude of the barge's acceleration?

SOLUTION

Given: $v_i = 1.00$ m/s

$\Delta t = 30.0$ s

$\Delta x = 60.2$ m

Unknown: $a = ?$

Use the equation for displacement with constant uniform acceleration.

$$\Delta x = v_i \Delta t + \tfrac{1}{2} a \Delta t^2$$

Rearrange the equation to solve for a.

$$\tfrac{1}{2} a \Delta t^2 = \Delta x - v_i \Delta t$$

$$a = \frac{2(\Delta x - v_i \Delta t)}{\Delta t^2}$$

$$a = \frac{(2)[60.2\ \text{m} - (1.00\ \text{m/s})(30.0\ \text{s})]}{(30.0\ \text{s})^2}$$

$$a = \frac{(2)(60.2\ \text{m} - 30.0\ \text{m})}{9.00 \times 10^2\ \text{s}^2}$$

$$a = \frac{(2)(30.2\ \text{m})}{9.00 \times 10^2\ \text{s}^2}$$

$$a = \boxed{6.71 \times 10^{-2}\ \text{m/s}^2}$$

ADDITIONAL PRACTICE

1. **The flight speed of a small bottle rocket can vary greatly, depending on how well its powder burns. Suppose a rocket is launched from rest so that it travels 12.4 m upward in 2.0 s. What is the rocket's net acceleration?**
2. **The shark can accelerate to a speed of 32.0 km/h in a few seconds. Assume that it takes a shark 1.5 s to accelerate uniformly from 2.8 km/h to 32.0 km/h. What is the magnitude of the shark's acceleration?**
3. In order for the Wright brothers' 1903 flyer to reach launch speed, it had to be accelerated uniformly along a track that was 18.3 m long. A system of pulleys and falling weights provided the acceleration. If the flyer was initially at rest and it took 2.74 s for the flyer to travel the length of the track, what was the magnitude of its acceleration?

4. **A certain roller coaster increases the speed of its cars as it raises them to the top of the incline. Suppose the cars move at 2.3 m/s at the base of the incline and are moving at 46.7 m/s at the top of the incline. What is the magnitude of the net acceleration if it is uniform acceleration and takes place in 7.0 s?**
5. **A ship with an initial speed of 6.23 m/s approaches a dock that is 255 m away. If the ship accelerates uniformly and comes to rest in 82 s, what is its acceleration?**
6. Although tigers are not the fastest of predators, they can still reach and briefly maintain a speed of 55 km/h. Assume that a tiger takes 4.1 s to reach this speed from an initial speed of 11 km/h. What is the magnitude of the tiger's acceleration, assuming it accelerates uniformly?
7. **Assume that a catcher in a professional baseball game catches a ball that has been pitched with an initial velocity of 42.0 m/s to the southeast. If the catcher uniformly brings the ball to rest in 0.0090 s through a distance of 0.020 m to the southeast, what is the ball's acceleration?**
8. **A crate is carried by a conveyor belt to a loading dock. The belt speed uniformly increases slightly, so that for 28.0 s the crate accelerates by 0.035 m/s^2. If the crate's initial speed is 0.76 m/s, what is its final speed?**
9. **A plane starting at rest at the south end of a runway undergoes a uniform acceleration of 1.60 m/s^2 to the north. At takeoff, the plane's velocity is 72.0 m/s to the north.**
   a. What is the time required for takeoff?
   b. How far does the plane travel along the runway?
10. A cross-country skier with an initial forward velocity of +4.42 m/s accelerates uniformly at −0.75 m/s^2.
    a. How long does it take the skier to come to a stop?
    b. What is the skier's displacement in this time interval?