

Motion in One Dimension

Problem A**AVERAGE VELOCITY AND DISPLACEMENT****PROBLEM**

The fastest fish, the sailfish, can swim 1.2×10^2 km/h. Suppose you have a friend who lives on an island 16 km away from the shore. If you send a message using a sailfish as a messenger, how long will it take for the message to reach your friend?

SOLUTION

Given: $v_{avg} = 1.2 \times 10^2$ km/h

$$\Delta x = 16 \text{ km}$$

Unknown: $\Delta t = ?$

Use the definition of average speed to find Δt .

$$v_{avg} = \frac{\Delta x}{\Delta t}$$

Rearrange the equation to calculate Δt .

$$\Delta t = \frac{\Delta x}{v_{avg}}$$

$$\begin{aligned} \Delta t &= \frac{16 \text{ km}}{\left(1.2 \times 10^2 \frac{\text{km}}{\text{h}}\right) \left(\frac{1 \text{ h}}{60 \text{ min}}\right)} = \frac{16 \text{ km}}{2.0 \text{ km/min}} \\ &= 8.0 \text{ min} \end{aligned}$$

ADDITIONAL PRACTICE

- The Sears Tower in Chicago is 443 m tall. Joe wants to set the world's stair climbing record and runs all the way to the roof of the tower. If Joe's average upward speed is 0.60 m/s, how long will it take Joe to climb from street level to the roof of the Sears Tower?**
- An ostrich can run at speeds of up to 72 km/h. How long will it take an ostrich to run 1.5 km at this top speed?**
- A cheetah is known to be the fastest mammal on Earth, at least for short runs. Cheetahs have been observed running a distance of 5.50×10^2 m with an average speed of 1.00×10^2 km/h.**
 - How long would it take a cheetah to cover this distance at this speed?**
 - Suppose the average speed of the cheetah were just 85.0 km/h. What distance would the cheetah cover during the same time interval calculated in (a)?**

- 4. A pronghorn antelope has been observed to run with a top speed of 97 km/h. Suppose an antelope runs 1.5 km with an average speed of 85 km/h, and then runs 0.80 km with an average speed of 67 km/h.**
- How long will it take the antelope to run the entire 2.3 km?**
 - What is the antelope's average speed during this time?**
5. Jupiter, the largest planet in the solar system, has an equatorial radius of about 7.1×10^4 km (more than 10 times that of Earth). Its period of rotation, however, is only 9 h, 50 min. That means that every point on Jupiter's equator "goes around the planet" in that interval of time. Calculate the average speed (in m/s) of an equatorial point during one period of Jupiter's rotation. Is the average velocity different from the average speed in this case?
- 6. The peregrine falcon is the fastest of flying birds (and, as a matter of fact, is the fastest living creature). A falcon can fly 1.73 km downward in 25 s. What is the average velocity of a peregrine falcon?**
7. The black mamba is one of the world's most poisonous snakes, and with a maximum speed of 18.0 km/h, it is also the fastest. Suppose a mamba waiting in a hide-out sees prey and begins slithering toward it with a velocity of +18.0 km/h. After 2.50 s, the mamba realizes that its prey can move faster than it can. The snake then turns around and slowly returns to its hide-out in 12.0 s. Calculate
- the mamba's average velocity during its return to the hideout.
 - the mamba's average velocity for the complete trip.
 - the mamba's average speed for the complete trip.
8. In the Netherlands, there is an annual ice-skating race called the "Tour of the Eleven Towns." The total distance of the course is 2.00×10^2 km, and the record time for covering it is 5 h, 40 min, 37 s.
- Calculate the average speed of the record race.
 - If the first half of the distance is covered by a skater moving with a speed of $1.05v$, where v is the average speed found in (a), how long will it take to skate the first half? Express your answer in hours and minutes.