Velocity

Math Skills

After you study each sample problem and solution, work out the practice problems on a separate sheet of paper. Write your answers in the spaces provided.

PRACTICE

1. Suppose the polar bear was running on land instead of swimming. If the polar bear runs at a speed of about 8.3 m/s, how far will it travel in 10.0 hours?

2. Like the polar bear, the walrus is a strong swimmer, although it does not have the same endurance. For short periods of time, a walrus can swim at an average speed of 9.7 m/s. How far would a walrus swim at this speed in 3.4 minutes?

3. The maximum posted speed limit on the U.S. Interstate Highway System is found in rural areas of several western states. This maximum speed is 75 mi/h, or 121 km/h. What is the distance, in kilometers, that a car a travels if it moves continuously at this speed for 3 hours and 20 minutes?

4. For normal situations, the minimum speed limit throughout the U.S. Interstate Highway System is 45 mi/h, or 72 km/h. How far, in kilometers, will a car travel if it moves continuously at this speed for 3 hours and 20 minutes?

5. Various types of tree sloths share the honor of being the slowest-moving mammals. An average tree sloth moves at a speed of 0.743 m/s. How long does it take a sloth moving at this speed to travel 22.30 m?

6. The longest stretch of straight railroad tracks lies across the desolate Nullarbor Plain, between the Australian cities of Adelaide and Perth. The tracks extend a distance of 478 km without a curve. How long would it take a train, moving at a constant speed of 97 km/h, to travel this length of track?

7. The Concorde is the fastest supersonic passenger jet. How long would the Concorde take to travel 6,265 km between New York City and London, assuming that the jet travels at its maximum speed of 2.150×10^3 km/h during the entire trip?

8. The longest distance in a track-and-field event is the 10 km run. The record holder for the women's 10 km run is Wang Junxia of China. Assuming that she ran 10.00 km at an average speed of 5.644 m/s, what was her time?

9. The cheetah, the fastest of land animals, can run 274 m in 8.65 s at its top speed. What is the cheetah's top speed?

13. The typical snail doesn't cover very much ground even when it is moving at its maximum speed, which is 5.0×10^{-2} m/h. How far will a snail travel if it moves at its top speed for 45 minutes?

14. Motion pictures typically are filmed and shown at a speed of 24 frames per second, where a frame is a single photographic image in the film. A motion-picture camera that moves the film at 2.4×10^{5} frames per second is used in high-speed photography. When the film is shown again at 24 frames per second, the filmed object seems to move very slowly. This technique is used to analyze the motion of objects, like bullets, that move too quickly to be observed by the human eye. If a frame of 16-mm film is 0.75 cm in length, how fast does the film move through the high-speed camera when the film is being exposed?

15. In 1926, Gertrude Ederle was the first American woman to swim across the English Channel. At that time, she set the world record for crossing the channel with an average speed of 0.725 m/s. Assuming that the distance Ederle swam was 37.9 km (the shortest distance between England and France), how long did it take her to swim the channel?

16. Bonnie Blair set the world record for women's speed skating in 1995 with an average speed of 12.9 m/s. How far would Blair have traveled at this speed in 5.00 minutes?

17. Although they seem to remain unchanged, many mountains undergo steady growth. If erosion and weathering are ignored, some mountains, like the San Gabriels in southern California, grow as much as 1.0 cm in a year. If a year is considered to be exactly 365 days, what is the speed at which the San Gabriel Mountains grow in kilometers per hour?

18. The Trans-Siberian Railroad is the longest single railroad in the world. Starting in Moscow, the tracks stretch 9,354 km across the Siberian frontier to Vladivostok, located at the edge of the Pacific Ocean. If you were to leave Moscow and travel on the railroad at an average speed of 90.0 km/h, how long would it take for you to reach Vladivostok?

19. The largest sheep and cattle ranches in the world are in Australia. Because some of these ranches are as large in area as Connecticut, the fences needed to protect the livestock from dingos and other predators are extensive. The world's longest "dingo-proof" fence is 5,530 km long. Suppose you were to travel around this fence in a car at an average speed of 45 km/h. How long would it take you to return to your starting point?

20. Stars do not appear to move because they are so far away. In truth, stars actually move at fairly high speeds. Consider the relatively close star Sirius, which is moving away from our solar system at a speed of about 17.8 km/s. How far will this star travel in 2,590 years, the time it takes for Sirius to move 1° across the sky?

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After you study each sample problem and solution, work out the practice problems on a separate sheet of paper. Write your answers in the spaces provided.

PRACTICE

1. Suppose the polar bear was running on land instead of swimming. If the polar bear runs at a speed of about 8.3 m/s, how far will it travel in 10.0 hours?

$\frac{10\,hr}{1} \left| \frac{60\,min}{1\,hr} \right| \frac{60\,s}{1\,min} = 36000\,s$

$v = \frac{d}{t}$ $8.3\,m/s = \frac{d}{36000\,s}$ $d = 298800\,m = 3.0 \times 10^5\,m$

2. Like the polar bear, the walrus is a strong swimmer, although it does not have the same endurance. For short periods of time, a walrus can swim at an average speed of 9.7 m/s. How far would a walrus swim at this speed in 3.4 minutes?

$\frac{3.4\,min}{1} \left| \frac{60\,s}{1\,min} \right. = 204\,s$

$v = \frac{d}{t}$ $9.7\,m/s = \frac{d}{204\,s}$ $d = 1978.8\,m = 1.9 \times 10^3\,m$ or $1.9\,KM$

3. The maximum posted speed limit on the U.S. Interstate Highway System is found in rural areas of several western states. This maximum speed is 75 mi/h, or 121 km/h. What is the distance, in kilometers, that a car a travels if it moves continuously at this speed for 3 hours and 20 minutes?

$\frac{20\,min}{1} \left| \frac{1\,hr}{60\,min} \right. = .33\,hr$ $+3\,hrs$

$v = \frac{d}{t}$ $121\,km/hr = \frac{d}{3.33\,hr}$ $d = 402.93\,km = 403\,km$

4. For normal situations, the minimum speed limit throughout the U.S. Interstate Highway System is 45 mi/h, or 72 km/h. How far, in kilometers, will a car travel if it moves continuously at this speed for 3 hours and 20 minutes?

$v = \frac{d}{t}$ $72\,km/hr = \frac{d}{3.33\,hr}$ $d = 239.76\,km = 2.4 \times 10^2\,km$

5. Various types of tree sloths share the honor of being the slowest-moving mammals. An average tree sloth moves at a speed of 0.743 m/s. How long does it take a sloth moving at this speed to travel 22.30 m?

$t \cdot .743 = \frac{22.30}{t} \cdot t$

$v = \frac{d}{t}$ $.743\,m/s = \frac{22.30\,m}{t}$ $t = 30.0\,s$

6. The longest stretch of straight railroad tracks lies across the desolate Nullarbor Plain, between the Australian cities of Adelaide and Perth. The tracks extend a distance of 478 km without a curve. How long would it take a train, moving at a constant speed of 97 km/h, to travel this length of track?

$t \cdot 97 = \frac{478}{t} \cdot t$

$v = \frac{d}{t}$ $97\,km/hr = \frac{478\,km}{t}$ $t = 4.9\,s$

7. The Concorde is the fastest supersonic passenger jet. How long would the Concorde take to travel 6,265 km between New York City and London, assuming that the jet travels at its maximum speed of 2.150×10^3 km/h during the entire trip?

$.914\,hr \left| \frac{60\,min}{1\,hr} \right. = 54.84\,min$

$.84\,min \left| \frac{60\,s}{1\,min} \right. = 50\,sec$

$t = 2\,hr\ 54\,min\ 50\,sec$

$v = \frac{d}{t}$ $2.150 \times 10^3\,km/hr = \frac{6265\,km}{t}$ $t = 2.914\,hrs$

8. The longest distance in a track-and-field event is the 10 km run. The record holder for the women's 10 km run is Wang Junxia of China. Assuming that she ran 10.00 km at an average speed of 5.644 m/s, what was her time?

$1772\,s \left| \frac{1\,min}{60\,s} \right. = 29.53\,min$

$.53\,min \left| \frac{60\,s}{1\,min} \right. = 32\,s$

$t = 29\,min\ 32\,s$

$v = \frac{d}{t}$ $5.644\,m/s = \frac{10\,000\,m}{t}$ $t = 1772\,sec$

9. The cheetah, the fastest of land animals, can run 274 m in 8.65 s at its top speed. What is the cheetah's top speed?

$v = d/t$ $v = \frac{274\,m}{8.65\,s} = 31.7\,m/s$

13. The typical snail doesn't cover very much ground even when it is moving at its maximum speed, which is 5.0×10^{-2} m/h. How far will a snail travel if it moves at its top speed for 45 minutes?

$\frac{45 \text{ min}}{} \left| \frac{1 \text{ hr}}{60 \text{ min}} \right. = .75 \text{ hr}$

$V = d/t \qquad 5.0 \times 10^{-2} \text{ m/h} = \frac{d}{.75 \text{ hr}} \qquad d = .0375 \text{ m} = 3.8 \times 10^{-2} \text{ m}$

14. Motion pictures typically are filmed and shown at a speed of 24 frames per second, where a frame is a single photographic image in the film. A motion-picture camera that moves the film at 2.4×10^5 frames per second is used in high-speed photography. When the film is shown again at 24 frames per second, the filmed object seems to move very slowly. This technique is used to analyze the motion of objects, like bullets, that move too quickly to be observed by the human eye. If a frame of 16-mm film is 0.75 cm in length, how fast does the film move through the high-speed camera when the film is being exposed?

$\frac{.75 \text{ cm}}{} \left| \frac{1 \text{ m}}{100 \text{ cm}} \right. = .0075 \text{ m} = 7.5 \times 10^{-2} \text{ m}$

$\frac{.75 \text{ cm}}{} \left| \frac{1 \text{ m}}{100 \text{ cm}} \right. = .0075 \text{ m} = 7.5 \times 10^{-3} \text{ m}$

$V = \frac{d}{t} = \text{m/s} \qquad \frac{2.4 \times 10^5 \text{ frames}}{1 \text{ second}} \times \frac{7.5 \times 10^{-3} \text{ m}}{\text{frame}} = 1800 \text{ m/s} = 1.8 \times 10^3 \text{ m/s}$

15. In 1926, Gertrude Ederle was the first American woman to swim across the English Channel. At that time, she set the world record for crossing the channel with an average speed of 0.725 m/s. Assuming that the distance Ederle swam was 37.9 km (the shortest distance between England and France), how long did it take her to swim the channel?

$\frac{37.9 \text{ KM}}{} \left| \frac{1000 \text{ m}}{1 \text{ KM}} \right. = 37900 \text{ m}$

$\frac{52276 \text{ s}}{} \left| \frac{1 \text{ min}}{60 \text{ s}} \right| \frac{1 \text{ hr}}{60 \text{ min}} = 14.52 \text{ hr}$

$V = \frac{d}{t} \qquad .725 \text{ m/s} = \frac{37900 \text{ m}}{t} \qquad t = 52276 \text{ s} = 14 \text{ hr } 31 \text{ min}$

$\frac{.52 \text{ hr}}{} \left| \frac{60 \text{ min}}{1 \text{ h}} \right. = 31 \text{ min}$

16. Bonnie Blair set the world record for women's speed skating in 1995 with an average speed of 12.9 m/s. How far would Blair have traveled at this speed in 5.00 minutes?

$\frac{5.00 \text{ min}}{} \left| \frac{60 \text{ s}}{1 \text{ min}} \right. = 300 \text{ sec}$

$V = \frac{d}{t} \qquad 12.9 \text{ m/s} = \frac{d}{300 \text{ s}} \qquad d = 3870 \text{ m} = 3.87 \times 10^3 \text{ m or } 3.87 \text{ KM}$

17. Although they seem to remain unchanged, many mountains undergo steady growth. If erosion and weathering are ignored, some mountains, like the San Gabriels in southern California, grow as much as 1.0 cm in a year. If a year is considered to be exactly 365 days, what is the speed at which the San Gabriel Mountains grow in kilometers per hour?

$\frac{365 \text{ day}}{} \left| \frac{24 \text{ hr}}{1 \text{ day}} \right. = 8760 \text{ hr}$

$\frac{1 \text{ cm}}{} \left| \frac{1 \text{ m}}{100 \text{ cm}} \right| \frac{1 \text{ KM}}{1000 \text{ m}} = 1.0 \times 10^{-5} \text{ KM}$

$.00001 \text{ km}$

$V = \frac{d}{t} \qquad \frac{1.0 \times 10^{-5} \text{ KM}}{8760} = 1 \times 10^{-9} \text{ KM/hr}$

18. The Trans-Siberian Railroad is the longest single railroad in the world. Starting in Moscow, the tracks stretch 9,354 km across the Siberian frontier to Vladivostok, located at the edge of the Pacific Ocean. If you were to leave Moscow and travel on the railroad at an average speed of 90.0 km/h, how long would it take for you to reach Vladivostok?

$V = \frac{d}{t} \qquad 90.0 \text{ KM/hr} = \frac{9,354 \text{ KM}}{t} \qquad t = 104 \text{ hrs.}$

19. The largest sheep and cattle ranches in the world are in Australia. Because some of these ranches are as large in area as Connecticut, the fences needed to protect the livestock from dingos and other predators are extensive. The world's longest "dingo-proof" fence is 5,530 km long. Suppose you were to travel around this fence in a car at an average speed of 45 km/h. How long would it take you to return to your starting point?

$V = \frac{d}{t} \qquad 45 \text{ KM/hr} = \frac{5530 \text{ KM}}{t} \qquad t = 122.9 \text{ hr} = 120 \text{ hrs}$

20. Stars do not appear to move because they are so far away. In truth, stars actually move at fairly high speeds. Consider the relatively close star Sirius, which is moving away from our solar system at a speed of about 17.8 km/s. How far will this star travel in 2,590 years, the time it takes for Sirius to move 1° across the sky?

$\frac{2590 \text{ yr}}{} \left| \frac{365 \text{ d}}{1 \text{ yr}} \right| \frac{24 \text{ hr}}{1 \text{ day}} \left| \frac{60 \text{ min}}{1 \text{ hr}} \right| \frac{60 \text{ s}}{1 \text{ min}} = 8.17 \times 10^{10} \text{ s}$

$V = \frac{d}{t} \qquad 17.8 \frac{\text{KM}}{\text{s}} = \frac{d}{8.17 \times 10^{10} \text{ s}} \qquad = 1.45 \times 10^{12} \text{ KM}$