UNIT 1 Problems

DIMENSIONAL ANALYSIS

4. The "extreme" prefixes that are officially recognized are *yocto*, which indicates a fraction equal to 10^{-24}, and *yotta*, which indicates a factor equal to 10^{24}. The maximum distance from Earth to the sun is 152 100 000 km. Using scientific notation, express this distance in

a. yoctometers (ym).
b. yottameters (Ym).

5. In 1993, the total production of nuclear energy in the world was 2.1×10^{15} watt-hours, where a watt is equal to one joule (J) per second. Express this number in

a. joules.
b. gigajoules.

AVERAGE VELOCITY AND DISPLACEMENT

1. 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?

2. 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?

3. 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.

a. How long would it take a cheetah to cover this distance at this speed?
b. 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)?

AVERAGE ACCELERATION

1. If the vessel in the sample problem accelerates for 1.00 min, what will its speed be after that minute? Calculate the answer in both meters per second and kilometers per hour.
2. In 1935, a French destroyer, *La Terrible,* attained one of the fastest speeds for any standard warship. Suppose it took 2.0 min at a constant acceleration of 0.19 m/s^2 for the ship to reach its top speed after starting from rest. Calculate the ship's final speed.
3. In 1934, the wind speed on Mt. Washington in New Hampshire reached a record high. Suppose a very sturdy glider is launched in this wind, so that in 45.0 s the glider reaches the speed of the wind. If the

9. In 1993, bicyclist Rebecca Twigg of the United States traveled 3.00 km in 217.347 s. Suppose Twigg travels the entire distance at her average speed and that she then accelerates at $-1.72\ m/s^2$ to come to a complete stop after crossing the finish line. How long does it take Twigg to come to a stop?
10. During the Winter Olympic games at Lillehammer, Norway, in 1994, Dan Jansen of the United States skated 5.00×10^2 m in 35.76 s. Suppose it takes Jansen 4.00 s to increase his velocity from zero to his maximum velocity, which is 10.0 percent greater than his average velocity during the whole run. Calculate Jansen's average acceleration during the first 4.00 s.

DISPLACEMENT WITH CONSTANT ACCELERATION

1. In 1993, Ileana Salvador of Italy walked 3.0 km in under 12.0 min. Suppose that during 115 m of her walk Salvador is observed to steadily increase her speed from 4.20 m/s to 5.00 m/s. How long does this increase in speed take?
2. In a scientific test conducted in Arizona, a special cannon called HARP (High Altitude Research Project) shot a projectile straight up to an altitude of 180.0 km. If the projectile's initial speed was 3.00 km/s, how long did it take the projectile to reach its maximum height?
3. The fastest speeds traveled on land have been achieved by rocket-powered cars. The current speed record for one of these vehicles is about 1090 km/h, which is only 160 km/h less than the speed of sound in air. Suppose a car that is capable of reaching a speed of

1. In 1986, the first flight around the globe without a single refueling was completed. The aircraft's average speed was 186 km/h. If the airplane landed at this speed and accelerated at $-1.5\ m/s^2$, how long did it take for the airplane to stop?

2. In 1976, Gerald Hoagland drove a car over 8.0×10^2 km in reverse. Fortunately for Hoagland and motorists in general, the event took place on a special track. During this drive, Hoagland's average velocity was about –15.0 m/s. Suppose Hoagland decides during his drive to go forward. He applies the brakes, stops, and then accelerates until he moves forward at same speed he had when he was moving backward. How long would the entire reversal process take if the average acceleration during this process is $+2.5\ m/s^2$?

3. The first permanent public railway was built by George Stephenson and opened in Cleveland, Ohio, in 1825. The average speed of the trains was 24.0 km/h. Suppose a train moving at this speed accelerates $-0.20\ m/s^2$ until it reaches a speed of 8.0 km/h. How long does it take the train to undergo this change in speed?

5. In a 1986 bicycle race, Fred Markham rode his bicycle a distance of 2.00×10^2 m with an average speed of 105.4 km/h. Markham and the bicycle started the race with a certain initial speed.
   a. Find the time it took Markham to cover 2.00×10^2 m.
   b. Suppose a car moves from rest under constant acceleration. What is the magnitude of the car's acceleration if the car is to finish the race at exactly the same time Markham finishes the race?

VELOCITY AND DISPLACEMENT WITH CONSTANT ACCELERATION

13. Peter Rosendahl rode his unicycle a distance of 1.00×10^2 m in 12.11 s. If Rosendahl started at rest, what was the magnitude of his acceleration?

14. Suppose that Peter Rosendahl began riding the unicycle with a speed of 3.00 m/s and traveled a distance of 1.00×10^2 m in 12.11s. What would the magnitude of Rosendahl's acceleration be in this case?

15. In 1991, four English teenagers built an electric car that could attain a speed 30.0 m/s. Suppose it takes 8.0 s for this car to accelerate from 18.0 m/s to 30.0 m/s. What is the magnitude of the car's acceleration?

FINAL VELOCITY AFTER ANY DISPLACEMENT

3. The Boeing 747 can carry more than 560 passengers and has a maximum speed of about 9.70×10^2 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 m/s^2. If the mushroom is initially at rest, what will its velocity be after it has been displaced +64 m?

FALLING OBJECT

1. The John Hancock Center in Chicago is the tallest building in the United States in which there are residential apartments. The Hancock Center is 343 m tall. Suppose a resident accidentally causes a chunk of ice to fall from the roof. What would be the velocity of the ice as it hits the ground? Neglect air resistance.

2. Brian Berg of Iowa built a house of cards 4.88 m tall. Suppose Berg throws a ball from ground level with a velocity of 9.98 m/s straight up. What is the velocity of the ball as it first passes the top of the card house?

3. The Sears Tower in Chicago is 443 m tall. Suppose a book is dropped from the top of the building. What would be the book's velocity at a point 221 m above the ground? Neglect air resistance.

4. The tallest roller coaster in the world is the Desperado in Nevada. It has a lift height of 64 m. If an archer shoots an arrow straight up in the air and the arrow passes the top of the roller coaster 3.0 s after the arrow is shot, what is the initial speed of the arrow?