**Chapter 1**

1. Two spheres are cut from a certain uniform rock. One has radius 4.50 cm. The mass of the other is five times greater. Find its radius.

Solution:

2. A solid piece of lead has a mass of 23.94 g and a volume of 2.10 cm3. From these data, calculate the density of lead in SI units (kilograms per cubic meter).

Solution:

**Chapter 2**

1. A ball is thrown upward from the ground with an initial speed of 25 m/s; at the same instant, another ball is dropped from a building 15 m high. After how long will the balls be at the same height above the ground?

Solution:

2. A person takes a trip, driving with a constant speed of 89.5 km/h, except for a 22.0-min rest stop. If the person’s average speed is 77.8 km/h, (a) how much time is spent on the trip and (b) how far does the person travel?

Solution:

**Chapter 3**

1. Can the magnitude of a vector have a negative value?

Explain:

2. Two points in the *xy* plane have Cartesian coordinate (2.00, -4.00) m and (-3.00, 3.00) m. Determine (a) the distance between these points and (b) their polar coordinates.

Solution:

3. Given the displacement vectors = (3î - 4ĵ + 4k̂) m and = (2î + 3ĵ - 7k̂) m, find the magnitudes of the following vectors and express each in terms of its rectangular components. (a) (b) .

Solution:

**Chapter 4**

1. Diagram

Description automatically generatedA firefighter, a distance d from a burning building, directs a stream of water from a fire hose at angle ui above the horizontal as shown in Figure P4.11. If the initial speed of the stream is vi, at what height h does the water strike the building?

Solution:

2. The pilot of an airplane notes that the compass indicates a heading due west. The airplane’s speed relative to the air is 150 km/h. The air is moving in a wind at 30.0 km/h toward the north. Find the velocity of the airplane relative to the ground.

Solution:

**Chapter 5**

1. A rubber ball is dropped onto the floor. What force causes the ball to bounce?

Answer:

2. The average speed of a nitrogen molecule in air is about m/s, and its mass is kg. (a) If it takes s for a nitrogen molecule to hit a wall and rebound with the same speed but moving in the opposite direction, what is the average acceleration of the molecule during this time interval? (b) What average force does the molecule exert on the wall?

Solution:

3. If a man weighs 900 N on the Earth, what would he weigh on Jupiter, where the free-fall acceleration is 25.9 m/s2?

Solution:

**Chapter 6**

1. A hawk flies in a horizontal arc of radius 12.0 m at constant speed 4.00 m/s. (a) Find its centripetal acceleration. (b) It continues to fly along the same horizontal arc, but increases its speed at the rate of 1.20 m/s2. Find the acceleration (magnitude and direction) in this situation at the moment the hawk’s speed is 4.00 m/s.

Solution:

2. In the Bohr model of the hydrogen atom, an electron moves in a circular path around a proton. The speed of the electron is approximately 2.20 × 106 m/s. Find (a) the force acting on the electron as it revolves in a circular orbit of radius 0.529 × 10-10 m and (b) the centripetal acceleration of the electron.

Solution:

**Solutions for Chapter 1**

1. Two spheres are cut from a certain uniform rock. One has radius 4.50 cm. The mass of the other is five times greater. Find its radius.

Solution:

For either sphere the volume is  and the mass is

 We divide this equation for the larger sphere by the same equation for the smaller:



Then 

2. A solid piece of lead has a mass of 23.94 g and a volume of 2.10 cm3. From these data, calculate the density of lead in SI units (kilograms per cubic meter).

Solution:

From Table 14.1, the density of lead is 1.13 × 104 kg/m3 , so we should expect our calculated value to be close to this value. The density of water is 1.00 × 103 kg/m3 , so we see that lead is about 11 times denser than water, which agrees with our experience that lead sinks.

Density is defined as *p = m / V.* We must convert to SI units in the calculation.



Observe how we set up the unit conversion fractions to divide out the units of grams and cubic centimeters, and to make the answer come out in kilograms per cubic meter. At one step in the calculation, we note that **one million** cubic centimeters make one cubic meter. Our result is indeed close to the expected value. Since the last reported significant digit is not certain, the difference from the tabulated values is possibly due to measurement uncertainty and does not indicate a discrepancy.

**Solutions for Chapter 2**

1. A ball is thrown upward from the ground with an initial speed of 25 m/s; at the same instant, another ball is dropped from a building 15 m high. After how long will the balls be at the same height above the ground?

Solution:

The falling ball moves a distance of (15 m – *h*) before they meet, where *h* is the

height above the ground where they meet. We apply



to the falling ball to obtain



or  **[1]**

Applying  to the rising ball gives

 **[2]**

Combining equations [1] and [2] gives



or 

2. A person takes a trip, driving with a constant speed of 89.5 km/h, except for a 22.0-min rest stop. If the person’s average speed is 77.8 km/h, (a) how much time is spent on the trip and (b) how far does the person travel?

Solution:

(a) The total time for the trip is *t*total = *t*1 + 22.0 min = *t*1 + 0.367 h, where *t*1 is the time spent traveling at *v*1 = 89.5 km/h. Thus, the distance travelled is  which gives



or 

from which, *t*1= 2.44 h, for a total time of



(b) The distance travelled during the trip is  giving



**Solutions for Chapter 3**

1. Can the magnitude of a vector have a negative value?

Explain:

No, the magnitude of a vector is always positive. A minus sign in a vector only indicates direction, not magnitude.

2. Two points in the *xy* plane have Cartesian coordinate (2.00, -4.00) m and (-3.00, 3.00) m. Determine (a) the distance between these points and (b) their polar coordinates.

Solution:

(a) The distance between the points is given by





(b) To find the polar coordinates of each point, we measure the radial distance to that point and the angle it makes with the +*x* axis:







 measured from the +*x* axis.

3. Given the displacement vectors = (3î - 4ĵ + 4k̂) m and = (2î + 3ĵ - 7k̂) m, find the magnitudes of the following vectors and express each in terms of its rectangular components. (a) (b) .

Solution:

We carry out the prescribed mathematical operations using unit vectors.

(a) 

(b) 

**Solutions for Chapter 4**

1. Diagram

Description automatically generatedA firefighter, a distance d from a burning building, directs a stream of water from a fire hose at angle ui above the horizontal as shown in Figure P4.11. If the initial speed of the stream is vi, at what height h does the water strike the building?

Solution:

The horizontal component of displacement is xf = vxit = (vi cos*θ*i)t. Therefore, the time required to reach the building a distance *d* away is . At this time, the altitude of the water is 

Therefore, the water strikes the building at a height *h* above ground level of 

2. The pilot of an airplane notes that the compass indicates a heading due west. The airplane’s speed relative to the air is 150 km/h. The air is moving in a wind at 30.0 km/h toward the north. Find the velocity of the airplane relative to the ground.

Solution:

The westward speed of the airplane is the horizontal component of its velocity vector, and the northward speed of the wind is the vertical component of its velocity vector, which has magnitude and direction given by





**Solutions for Chapter 5**

1. A rubber ball is dropped onto the floor. What force causes the ball to bounce?

Answer:

The molecules of the floor resist the ball on impact and push the ball back, upward. The actual force acting is due to the forces between molecules that allow the floor to keep its integrity and to prevent the ball from passing through. Notice that for a ball passing through a window, the molecular forces weren’t strong enough.

2. The average speed of a nitrogen molecule in air is about m/s, and its mass is kg. (a) If it takes s for a nitrogen molecule to hit a wall and rebound with the same speed but moving in the opposite direction, what is the average acceleration of the molecule during this time interval? (b) What average force does the molecule exert on the wall?

Solution:

1. Let the *x* axis be in the original direction of the molecule’s motion.

Then, from  we have



1. For the molecule,  Its weight is negligible.



3. If a man weighs 900 N on the Earth, what would he weigh on Jupiter, where the free-fall acceleration is 25.9 m/s2?

Solution:

We are given, from which we can find the man’s mass,



Then, his weight on Jupiter is given by



**Solutions for Chapter 6**

1. A hawk flies in a horizontal arc of radius 12.0 m at constant speed 4.00 m/s. (a) Find its centripetal acceleration. (b) It continues to fly along the same horizontal arc, but increases its speed at the rate of 1.20 m/s2. Find the acceleration (magnitude and direction) in this situation at the moment the hawk’s speed is 4.00 m/s.

Solution:

A bird with a curved line

Description automatically generated with medium confidence

(a) The hawk’s centripetal acceleration is

![A black background with a black square

Description automatically generated with medium confidence]()

(b) The magnitude of the acceleration vector is



at an angle



2. In the Bohr model of the hydrogen atom, an electron moves in a circular path around a proton. The speed of the electron is approximately 2.20 × 106 m/s. Find (a) the force acting on the electron as it revolves in a circular orbit of radius 0.529 × 10-10 m and (b) the centripetal acceleration of the electron.

Solution:

1. The force acting on the electron in the Bohr model of the hydrogen atom is directed radially inward and is equal to



(b)

