**Chapter – 1**

1. **What mass of a material with density ρ is required to make a hollow spherical shell having inner radius r1 and outer radius r2?**

Solution:

The volume of a spherical shell can be calculated from



From the definition of density, , so



**2. 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 

**3. The position of a particle moving under uniform acceleration is some function of time and the acceleration. Suppose we write this position as x = kamtn, where k is a dimensionless constant. Show by dimensional analysis that this expression is satisfied if m=1 and n=2. Can this analysis give the value of k?**

**Solution:**

The term *x* has dimensions of L, *a* has dimensions of  and *t* has dimensions of T. Therefore, the equation has dimensions of



The powers of L and T must be the same on each side of the equation. Therefore,  and Likewise, equating terms in T, we see that *n* – 2*m* must equal 0. Thus, . The value of *k*, a dimensionless constant, 

**Chapter – 2**

1. **An electron in a cathode-ray tube accelerates uniformly from 2.00 3 104 m/s to 6.00 3 106 m/s over 1.50 cm.  
   (a) In what time interval does the electron travel this 1.50 cm?  
   (b) What is its acceleration?**

**Solution:**

We have   and 

(a) 



(b) :



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 

**3. 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 traveled is  which gives



or 

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



(b) The distance traveled during the trip is  giving



**Chapter – 3**

1. **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:



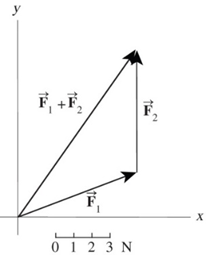




 measured from the +*x* axis.

1. A picture containing diagram

   Description automatically generated**A force** **of magnitude 6.00 units acts on an object at the origin in a direction *Ɵ* = 30.0° above the positive x axis (Fig. P3.7). A second force**  **of magnitude 5.00 units acts on the object in the direction of the positive y axis. Find graphically the magnitude and direction of the resultant force** .

**Solution:**

We find the resultant  graphically by placing the tail of  at the head of . The resultant force vector  is of magnitude  and at an angle of 

**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) 

**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 

1. **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





**3. A projectile is fired in such a way that its horizontal range is equal to three times its maximum height. What is the angle of projection?**

Solution:

We ignore the trivial case where the angle of projection equals zero degrees.



so 

or 

thus, 

**Chapter – 5**

1. **The average speed of a nitrogen molecule in air is about 6.70 3 102 m/s, and its mass is 4.68 3 10226 kg. (a) If it takes 3.00 3 10213 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.



1. **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



**3. A 3.00-kg object undergoes an acceleration given by**  **Find (a) the resultant force acting on the object and (b) the magnitude of the resultant force.**

Solution:

We use Newton’s second law to find the force as a vector and then the Pythagorean theorem to find its magnitude. The givens are *m* = 3.00 kg and 

(a) The total vector force is



(b) Its magnitude is



**Chapter – 6**

1. **Whenever two *Apollo* astronauts were on the surface of the Moon, a third astronaut orbited the Moon. Assume the orbit to be circular and 100 km above the surface of the Moon, where the acceleration due to gravity is 1.52 m/s2. The  
   radius of the Moon is 1.70 3 106 m. Determine (a) the astronaut’s orbital speed and (b) the period of the orbit.**

**Solution:**

(a) The astronaut’s orbital speed is found from Newton’s second law, with

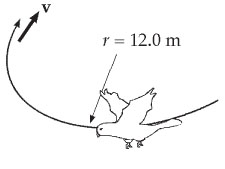
solving for the velocity gives



(b) To find the period, we use  and solve for *T*:



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) The hawk’s centripetal acceleration is



(b) The magnitude of the acceleration vector is



at an angle



**3. 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)

