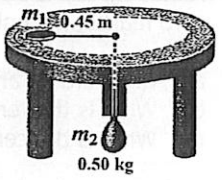
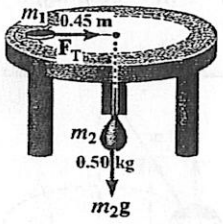
PROBLEM 2 Centripetal Acceleration and Centripetal Force

A flat puck is rotated in a circular path of radius 0.45 m on a horizontal frictionless table, and is held in this orbit by a string attached to a 0.50 kg sack through the central hole as shown in the diagram. The puck completes 5 rotations in 6.0 s.



a) Find the speed of the puck.
b) Find the centripetal acceleration.
c) Find the maximum mass of the puck.

Solution $m_2 = 0.50$ kg, $r = 0.45$ m, rotation = 5, $\Delta t = 6.0$ s



a) $\mathbf{T} = \dfrac{\Delta t}{\text{rotation}} = \dfrac{6.0}{5} = 1.2$ s

$\mathbf{v} = \dfrac{2\pi r}{T} = \dfrac{2\pi(0.45)}{1.2} = 2.356 \approx 2.4$ m/s

b) $\mathbf{a_c} = \dfrac{v^2}{r} = \dfrac{(2.356)^2}{0.45} = 12.33 \approx 12$ m/s^2

c) $F_C = F_T \qquad m_1 a_C = m_2 g$

$m_1(12.33) = (0.50)(9.8) \qquad m_1 = 0.40$ kg

RELATED PROBLEMS

4. A 0.20 kg stone on the end of a 0.60 m string is swung in a horizontal circle with a period of 1.2 s.

   a) What is the centripetal acceleration of the stone?

   b) What is the tension of the string?

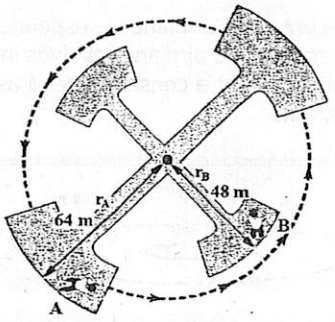
5. A truck can round on a flat circular track of radius 60 m at a maximum speed of 18 m/s under the dry condition.

   a) What is the minimum coefficient of friction between its tires and the track required to prevent the truck from skidding?

   b) If the track is wet and the coefficient of friction is reduced to 40% of the value under the dry condition, what is the maximum safe speed under the wet condition?

   c) What is the minimum time for the truck to complete one lap of the track under the wet condition?

6. A space station consists of two outer wings with a distance of 64 m and two inner wings with a distance of 48 m form the center as shown in the diagram. The station rotates, and the astronaut at A experiences an acceleration of 8.0 m/s^2.



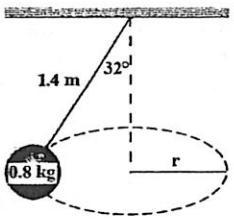
   a) What is the period of the rotation of the space station?

   b) If the mass of the astronaut at B is 52 kg, what are the astronaut's acceleration and normal force experienced by the wall?

   c) If the period of the rotation decreases, how does this change affect the normal force experienced by the astronauts?

PROBLEM 3 Conical Pendulum

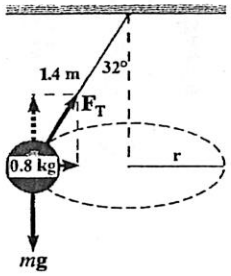
A 0.80 kg ball is swung at a constant speed in a horizontal circle so that the 1.4 m cord makes an angle of 32° with the vertical as shown in the diagram.



a) Draw a diagram showing the forces acting on the ball.
b) What is the tension of the cord?
c) What is the centripetal force on the ball?

Solution m = 0.80 kg, L = 1.4 m, r = L·sin θ = (1.4)(sin 32°) = 0.74 m

a)



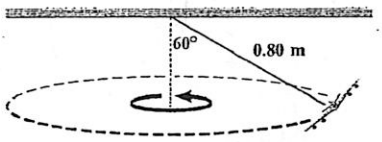
b) $F_{Tx} = F_T \sin 32°$ $F_{Ty} = F_T \cos 32°$

$mg = F_{Ty}$ $mg = F_T \cos 32°$ $F_T = \dfrac{mg}{\cos 32°} = \dfrac{(0.80)(9.8)}{\cos 32°} = 9.245 \approx 9.2$ N

c) **$F_C = F_{Tx}$** $F_C = F_T \sin 32° = (9.245) \sin 32° = 4.9$ N

RELATED PROBLEMS

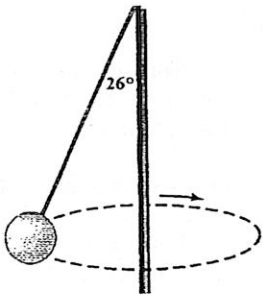
7. A radio-controlled airplane is suspended from a 0.80 m string. The airplane revolves in a horizontal circle at a constant speed as shown in the diagram.



a) What is the speed of the airplane?

b) What is the period of the revolution of the airplane?

8. A bead is swung in a horizontal circle so that the string makes 26° with the vertical as shown in the figure.



a) What is the centripetal acceleration of the bead?

b) If the period of the rotation of the bead is 1.6 s, what are the radius of the circle and the speed of the bead?