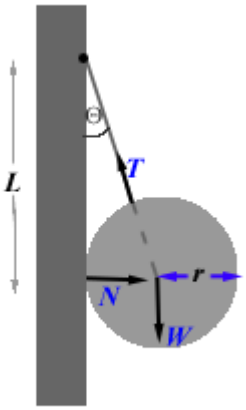
40.

Problem 13.12E (HRW)

A uniform sphere of weight W and radius r is held in place by a rope attached to a frictionless wall at a distance L above the centre of the sphere. (a) *We have to find the tension in the rope and* (b) *the force exerted on the sphere by the wall.*

Solution:



We will solve this problem by applying the conditions for static equilibrium. When the spherical ball is in equilibrium, torque about the point on the wall to which the rope is attached has to be zero, and the vector sum of forces acting on the sphere has to be zero. In addition to the weight *W* acting vertically downward at the centre of the ball the other forces acting on it are the tension *T* in the rope and the

normal force N exerted by the wall on the ball at the point of contact.

(b)

Let θ be the angle between the stretched rope and the vertical.

Condition of zero torque is

$NL = Wr.$

This gives the force exerted by the wall on the sphere to be $N = Wr/L$.

(a)

Condition that the net force in the vertical direction acting on the ball is zero gives

$T\cos\theta = W,$

or,

$$T = \frac{W}{\cos\theta} = \frac{W\left(L^2 + r^2\right)^{\frac{1}{2}}}{L} \ .$$