MECH 230 Dynamics Homework 5

Dr. Theresa Honein

Due Wednesday October 16, 2024

1. Read the problem statement of MKB 3/193.

3/193 SS The 0.4-lb ball and its supporting cord are revolving about the vertical axis on the fixed smooth conical surface with an angular velocity of 4 rad/sec. The ball is held in the position b = 14 in. by the tension T in the cord. If the distance b is reduced to the constant value of 9 in. by increasing the tension T in the cord, compute the new angular velocity ω and the work $U'_{1,2}$ done on the system by T.



- 2. Set up a cylindrical-polar coordinate system whose origin is taken to be at the vertex of the cone.
- 3. The position vector to the object of mass m can be written as

$$\mathbf{r} = r\mathbf{e}_r + z\mathbf{E}_z$$

Express r and z in terms of b and the 30° angle.

- 4. Differentiate the position vector to find the velocity vector of the particle of mass m in terms of b. At the instants considered, before and after the chord is shortened, b is constant.
- 5. For notational convenience, we also define the following unit vectors in the

Compiled on 10/11/2024 at 9:22am

 $\{\mathbf{e}_r, \mathbf{E}_z\}$ plane.

$$\mathbf{t} = -\cos(30^\circ)\mathbf{e}_r + \sin(30^\circ)\mathbf{E}_z$$
$$\mathbf{n} = \sin(30^\circ)\mathbf{e}_r + \cos(30^\circ)\mathbf{E}_z.$$

Add these vectors to your sketch of the cone.

- 6. Draw the free body diagram of the particle m and write the expressions of the forces acting on the particle where applicable.
- 7. Write the Work-Energy theorem for the particle. Is the total mechanical energy of the system conserved?
- 8. By looking at the moments of the forces, show that the angular momentum of the system in the fixed \mathbf{E}_z direction, $\mathbf{H}^O \cdot \mathbf{E}_z$, is conserved.
- 9. Calculate $\mathbf{H}^{O} \cdot \mathbf{E}_{z}$ and use the previously found conservation to find the angular velocity of the mass after b is shortened.
- 10. Compute the work done by the tension in the chord $U_{\mathbf{T},1-2}$ on the mass as the chord was shortened.