Problem Sheet No. 7

1. As the skateboarder negotiates the surface shown, his mass-center speed at θ = 0, 45°, and 90°are 8.5 m/s, 6 m/s, and 0 respectively. Determine the normal force between the surface and the skateboard wheels if the combine mass of the person and the skateboard is 70 kg and his center of mass is 750 mm from the surface.
   Ans. N_0 =2040 N, $N_{45°}$ =1158 N, $N_{90°}$= 0

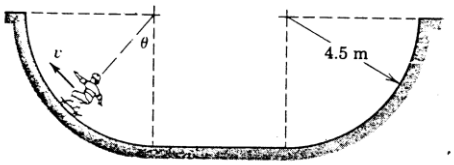

Figure-1

2. A small object A is held against the vertical side of the rotating cylindrical container of radius r due to centrifugal action. If the coefficient of static friction between the object and the container is μ_s, determine the expression for the minimum rotational rate $\theta = \omega$ of the container that will keep the object from slipping down the vertical side.

$$Ans. \omega = \sqrt{\frac{g}{\mu_s r}}$$

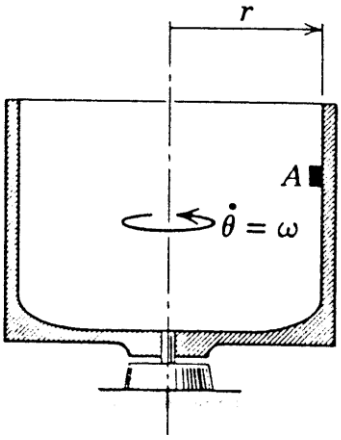

Figure-2

3. The small object is placed on the inner surface of the conical dish at the radius shown. If the coefficient of the static friction between the object and the conical surface is 0.03, for what of angular velocities ω about the vertical axis will the block remain on the dish without slipping? Assume that the speed changes are made slowly so that any acceleration may be neglected.
   Ans. 3.41< ω< 7.21 rad/s

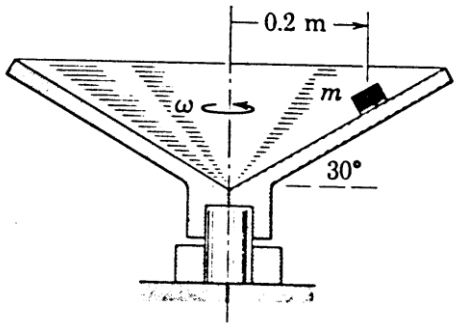

Figure-3

4. The small object of mass m is placed on the rotating conical surface at the radius shown. If the coefficient of static friction between the object and the rotating surface is 0.8, calculate the maximum angular velocity ω of the cone about the vertical axis for which the object will not slip. Assume very gradual angular velocity changes.
   Ans. ω = 2.73 r/s.

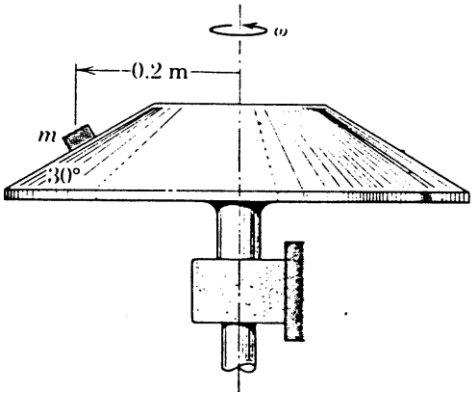

Figure-4

5. The small pendulum of mass m is suspended from a trolley that runs on a horizontal rail. The trolley and

pendulum are initially at rest with θ = 0. If the trolley is given a constant acceleration a = g, determine the maximum angle θmax through which the pendulum swings. Also find the tension T in the cord in the term of θ.

Ans.

$$\theta_{\max} = \pi/2, T = mg(3\sin\theta + 3\cos\theta - 2)$$

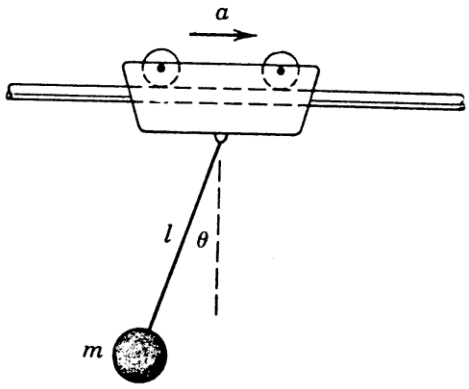

Figure-5