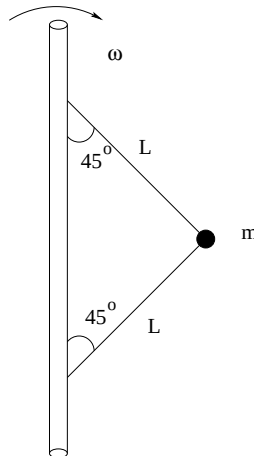


Course 141: MECHANICS

Problem Set 6

Date Issued: November 28, 2007

1. A sand-spraying locomotive sprays sand horizontally into a freight car. The locomotive and freight car are not attached, but the locomotive maintains the speed so that the distance to the freight car is constant. The sand is transferred at a rate $dm/dt = 10 \text{ kg/s}$ with a velocity of 5 m/s relative to the locomotive. The car starts from the rest with an initial mass of 2000 kg . Find its speed after 100 s .
2. The satellite's orbit is determined by the vector of initial velocity given to it by the launcher. A satellite is launched into a circular Earth orbit with altitude 400 km . However, the direction of satellite initial velocity is deviated from the target value by a small angle $\delta\alpha = 0.06 \text{ rad}$. Evaluate the difference between target altitude and actual perigee of the orbit reached.
3. A particle of mass m moves under a force $F = -cx^3$, where c is a positive constant. Find the function of the potential of the force. If the particle starts from rest at $x = -a$, what is its velocity when it reaches $x = 0$? Where in the subsequent motion does it instantaneously come to rest?
4. A mass m is connected to a vertical revolving axle by two strings of length l , each making an angle of 45° with the axle, as shown. Both the axle and mass are revolving with angular velocity ω in the gravitational field. Draw a clear force diagram for m . Find the tension in the upper string T_{up} , and lower string T_{down} . Answer clue: If $L\omega^2 = \sqrt{2}g$, $T_{up} = \sqrt{2}mg$.



5. Two people are standing on a 2 meter long platform, one at each end. The platform rolls without friction on the ground. One person throws a 6 kg ball to the other, who catches it. The ball travels nearly horizontally. Excluding the ball, the total mass of the platform and people is 118 kg . Because of the throw, this 118 kg mass recoils. How far does it move before coming to rest again?