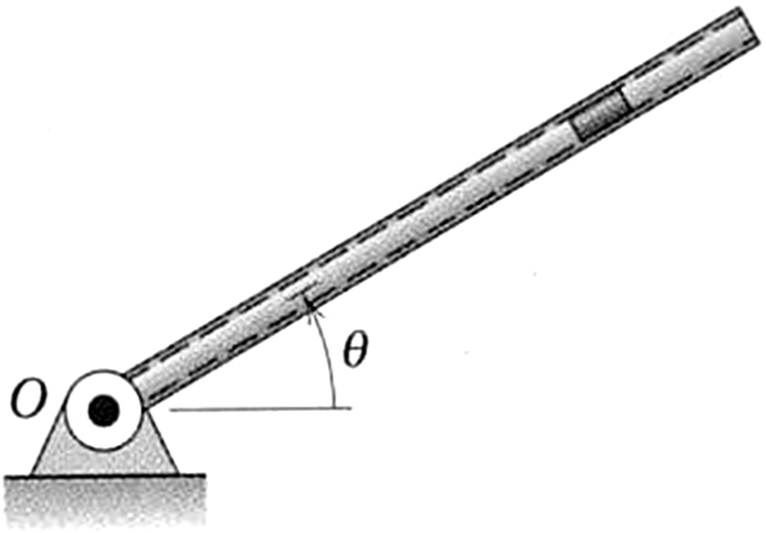
2.003/1.053 Dynamics and Controls I
Spring 2007
Problem Set 2

Issued on Tuesday, February 20^{th}
Due in lecture on Monday, February 26^{th}

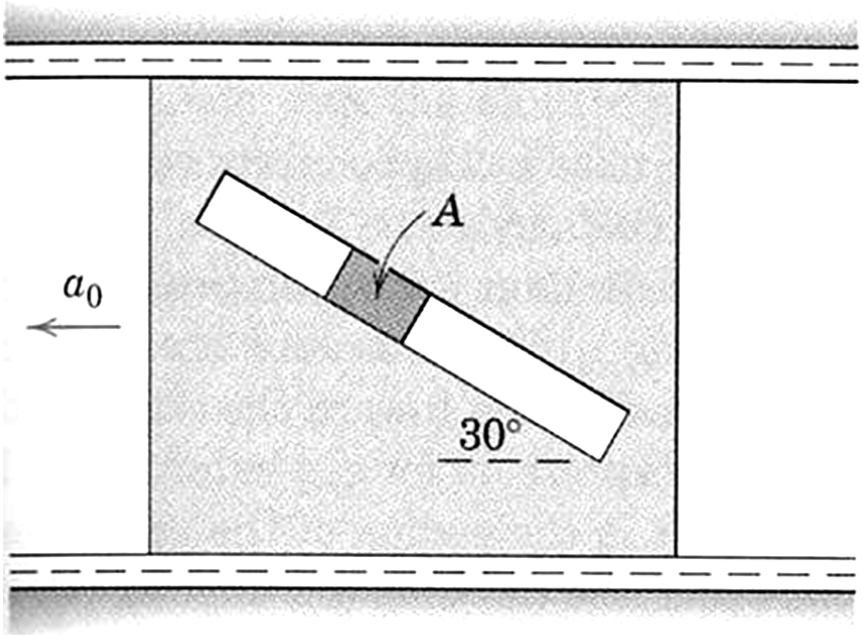
1 Pivoting tube

The hollow tube is pivoted about a horizontal axis through point O and it is made to rotate in the vertical plane with a constant counterclockwise angular velocity $\dot{\theta} = 3\,\text{rad/sec}$. If a 0.2-lb particle is sliding in the tube toward O with a velocity of 4ft/sec relative to the tube when the position $\theta = 30^\circ$ is assed, calculate the magnitude N of the normal force exerted by the wall of the tube on the particle at this instant.



2 Sliding plate

The slider A has a mass of 2 kg and moves with negligible friction in the 30° slot in the vertical sliding plate. What horizontal acceleration a_0 should be given to the plate so that the absolute acceleration of the slider will be vertically down? What is the value of the corresponding force R exerted on the slider by the slot?



3 Bungee jumper

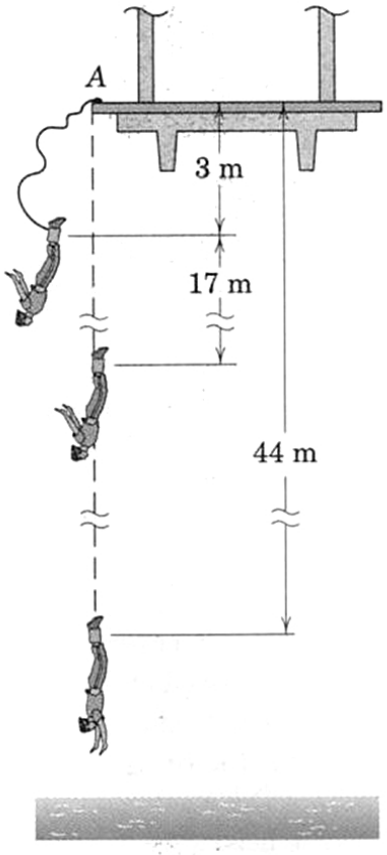
The bungee jumper, an 80-kg man, falls from the bridge at A with the bungee cord secured to his ankles. He falls 20 m before the 17-m length of elastic bungee cord begins to stretch. The man is observed to drop a total of 44 m before being projected upward. Neglect any energy loss and calculate

(a) the stiffness k of the bungee cord (increase in tension per meter of elongation),

(b) the maximum velocity $v_{\max}$ of the man during his fall, and

(c) his maximum acceleration $a_{\max}$.

Treat the man as a particle located at the end of the bungee cord.



4 Sliding collar on a vertical frame

If the vertical frame starts from rest with a constant acceleration a and the smooth sliding collar A is initially at rest in the bottom position $\theta = 0$, plot $\dot{\theta}$ as a function of θ and find the maximum position angle $\theta_{\max}$ reached by the collar. Use the values $a = g/2$ and $r = 0.3$ m.