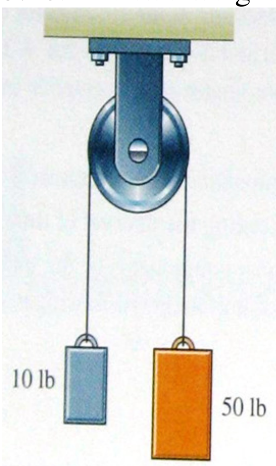
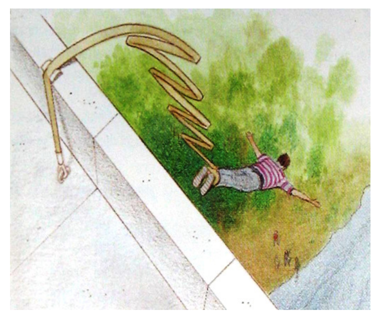
EGBE261: Biomechanics 2
Homework from Chapter 3: Force, Mass, and Acceleration

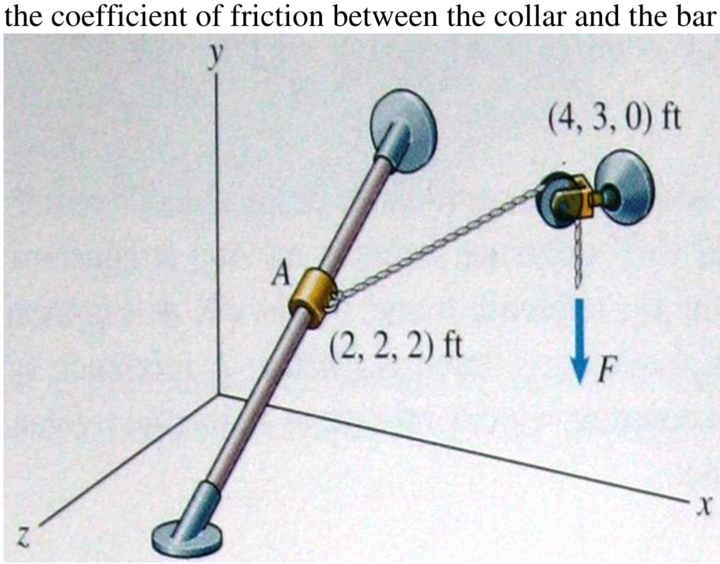
3.28. The two weights are released from rest. How far does the 50 lb weight fall in 0.5 s?



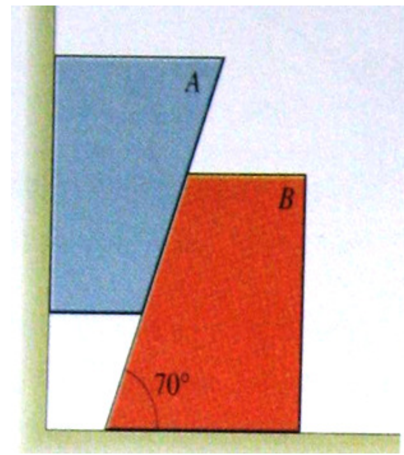
3.46. A 200-lb "bungee jumper" jumps from a bridge 130 ft above a river. The bungee cord has an unstretched length of 60 ft and has a spring constant k = 14 lb/ft. a) How far above the river is he when the cord brings him to a stop? B) What maximum force does the cord exert on him?



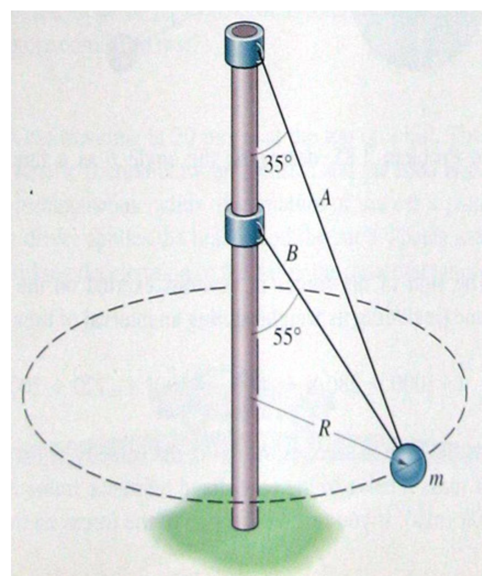
3.54. The acceleration of the 20 lb collar A is 2i + 3j – 3k (ft/s^2). Determine the force F if the coefficient of friction between the collar and the bar is $\mu_k = 0.1$.



3.62. Determine how long it takes block A to fall 1 ft if $\mu_k = 0.1$ at all the contacting surface. *(Hint: Use the fact that the components of the accelerations of the blocks perpendicular to their mutual interface must be equal).*

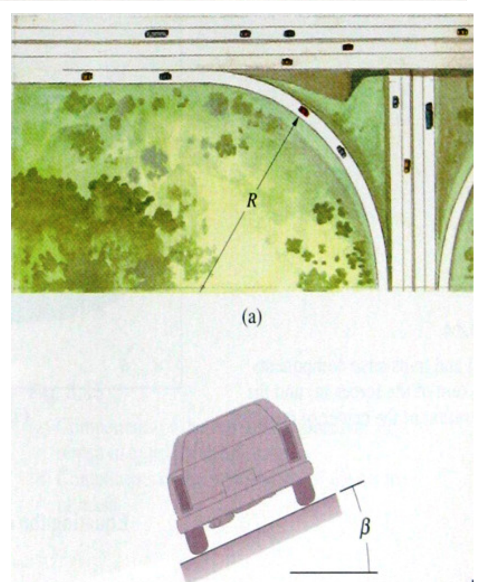


3.78. The 10-kg mass m rotates around the vertical pole in a horizontal circular path of radius R = 1m. What is the range of values of v for which the mass will remain in the circular path described?

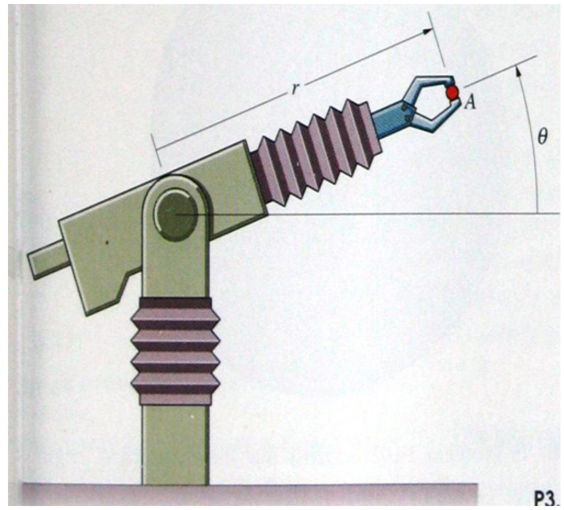


3.93. A freeway off-ramp is circular with radius R and the roadway is banked at an angle β. Show that the maximum constant velocity at which a car can travel the off-ramp without loosing traction is:

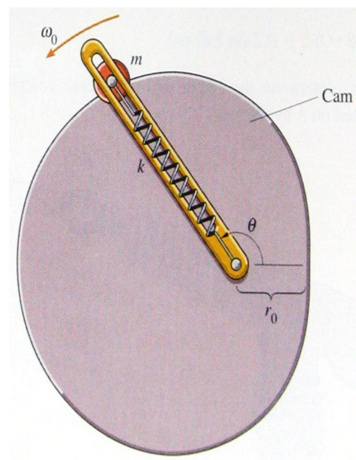
$$v = \sqrt{gR\left(\frac{\sin\beta + \mu_s \cos\beta}{\cos\beta - \mu_s \sin\beta}\right)}$$



3.96. The robot is programmed so that the 0.4-kg ball A describes the path: $r = 1 - 0.5\cos 2\pi t \quad m$, $\theta = 0.5 - 0.2\sin 2\pi t \quad rad$. At t = 2s, determine the radial and transverse components of the force exerted on A by the robot's jaws.



3.108. The slotted bar rotates in the horizontal plane with constant angular velocity ω_0. The mass m has a pin that fits in the slot of the bar. A spring holds the pin against the surface of the fixed cam. The surface of the cam is described by $r = r_0\left(2 - \cos\theta\right)$. Suppose that the unstretched length of the spring is r_0. Determine the smallest value of the spring constant k for which the pin will remain on the surface of the cam.



Matlab:

Many problems can't be solved using algebraic integration, such as the problem below. In other problems, there are no known equations – only data. We will encounter biomedical examples of this latter case later in this course.

In either case, we use numeric integration. In a laboratory, we often use a fourth-order Runge-Kutta method, but for this problem a first order Euler's method will be adequate. In Euler's method, $v_x(t_0+\Delta t)$ is expressed as a Taylor series. In your code, by setting the time step Δt to be a very small value, you can then ignore the second and higher orders in the equation to obtain the following equation:

$$v_x(t_0+\Delta t) = v_x(t_0) + \frac{1}{m}\sum F_x\left(t_0, x(t_0), v_x(t_0)\right)\Delta t .$$

We can approximate the position at $t_0+\Delta t$ in the same way, in which case we obtain:

$$x_x(t_0+\Delta t) = x_x(t_0) + v_x(t_0)\Delta t .$$

This process can be repeated once the new value is known, to find the next value. The technique becomes more accurate as Δt becomes smaller. The advantage in using a fourth order method, such as Runge-Kutta, is that you can obtain the same accuracy using larger time-steps, or more accurate answers using the same time steps.

Problem:

A 100 kg projectile is launched from x = 0, y = 0, with initial velocity $v_x = v_y = 400$ m/s. The aerodynamic drag force is of magnitude Cv^2.

A) Determine the trajectory for values of C of 0.002, 0.004, and 0.006.

B) Calculate the closed-form solution for C = 0, and compare the trajectory with your code (for C = 0).

Please submit a printout of your matlab code to receive class participation credit next week. Be sure to include your name, Engineering number, and Biomechanics 2 number in the top of the code. You get a bonus point if you use the Runge-Kutta method. If you do, please indicate this at the top of your code as well.