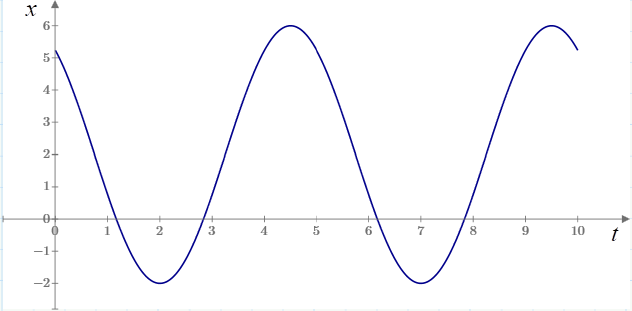
**Assignment 1 Due 1/24**

**Problem 1**. A 19th century amusement park ride consists of a spring attached to a box on wheels. You stretch the spring to some point, jump into the box, and then off you go! The following x(t) plot from that ride was recently found in a museum.



(a) What is the equilibrium length of the spring?

(b) What is the period? Frequency? Angular frequency?

(c) What is the amplitude?

(d) What is the phase constant (approximately)?

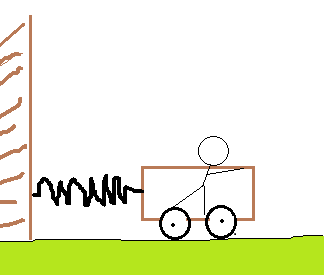
(e) Write down an expression for x(t), if you don’t mind.

(f) What is the maximum speed?

(g) What is the maximum acceleration?

(h) If the surface of the box were smooth, you’d be prone to slip back and forth. Indicate on the graph above, at what times you be most prone to do so. What minimum coefficient of static friction would there have to be between you and the box to prevent you from slipping?

**Problem 2**. Consider that amusement park spring ride again. Say the spring constant is k = 300N/m, and equilibrium length of the spring is ℓ = 3m. Someone holds the box at x = 2m, and you take a running start and jump into the box with velocity v = 7m/s. Your mass is m = 60kg. And the box’s mass is m = 40kg.



(a) Assuming the collision between you and the box happens instantaneously (and you stick together), what is yall’s (you and box) initial velocity? Have to use conservation of something to work this out!

(b) What will be your angular frequency? Period?

(c) What is the amplitude?

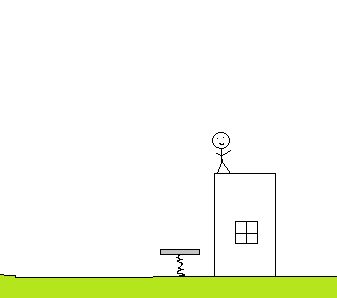
(d) What is the phase constant?

(e) Write down an expression for x(t), por favor.

(f) What is your maximum and minimum positions?

(g) What is the maximum speed?

**Problem 3**. Suppose you (mass m = 70kg) step off an 5m tall platform, onto 2m tall spring (k = 2000N/m). Starting time from when you hit the spring…



(a) what will be new equilibrium position about which you oscillate?

(b) what will be your period?

(c) what will be your amplitude of oscillation?

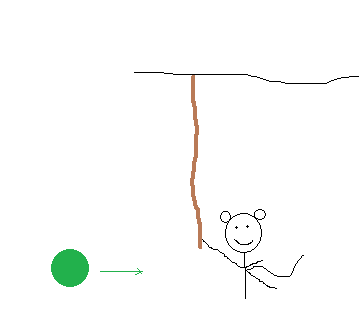
(d) what will be your phase constant?

(e) write down an expression for y(t), vy(t), and ay(t).

(f) What will be your position, velocity, acceleration at time t = 1s?

(g) would only gravity suffice to keep you on the spring platform?

**Problem 4.** A monkey (m = 10kg) hangs on a vine (can treat as a uniform board with mass m = 6kg) of length ℓ = 5m. You throw a watermellon (m = 3kg) horizontally at speed v = 18m/s, which the monkey catches.



(a) What will be the monkey’s period of oscillation?

(b) What would be the period if the speed of the watermelon were doubled?

**Problem 5.** A monkey (m = 10kg) hangs on a massless vine of length ℓ = 5m. You throw a watermellon (m = 3kg) horizontally at speed v = 18m/s, which the monkey catches. Supposing the catch happens instantaneously….

(a) What is monkey’s initial angle?

(b) What will be the monkey’s initial angular velocity after catching the watermelon? \*Hint: gotta use conservation of something here!

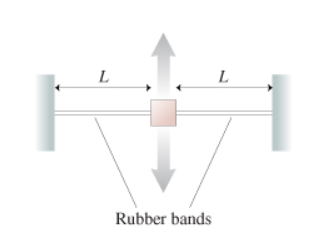
(c) What will be the monkey’s period of oscillation?

(d) What maximum angle will the monkey reach?

(e) What will be the monkey’s phase constant?

(f) Write down expressions for the monkey’s angle, angular velocity, and angular acceleration as a function of time.

**Problem 6.** Consider a mass, m, attached to two rubber bands each under tension T. If you were to displace the mass upwards a small amount, it would oscillate back and forth with some frequency f.



(a) write down an expression for the net force on the mass, ignoring gravity, if it is displaced a distance y above the horizontal, assuming that the tension in the rubber bands remains constant. Your expression should only contain L, T, and y. Also, use the small angle approximation sinθ ≈ tanθ.

(b) Wriite down N2L for the mass, as a differential equation.

(c) Plug in the trial solution y(t) = Acos(ωt+φ0) and solve for ω, and then the frequency, symbolically.