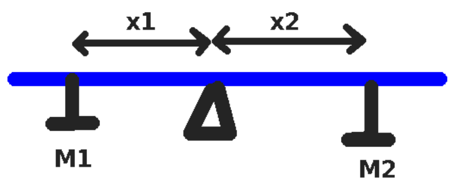
[1] A **massless** bar is balanced as shown (it is in static equilibrium). Two masses M2 and M2 are placed at distances x1 and x2 from the pivot as shown.

(a) Sketch and label on the diagram below all forces acting on the bar. You may label the force for the pivot as F_p.



(b) Write **each term** in the sum of the forces acting on the bar in terms of M_1 , M_2, and g. Be sure to get your signs included here.

(c) Assume the pivot and axis are located at the same location (shown in the diagram above).Write **each term** in the sum of torques about this axis in terms of M_1, M_2 , g, x_1 and x_2. Be sure to get your signs included here.

(d) Assuming static equilibrium, find the force from the pivot (F_p) in terms of M_1, M_2 and g.

(e) Assuming static equilibrium, find the value of x_2 in terms of x_1, M_1, and M_2.

(f) Suppose M_1=3M_2 and x_1=1 m. Provide a numerical value for x_2 with correct SI units.

[2] A spring-mass system has a spring constant k and a mass m is attached to the spring.

(a) Find the period (T) of small oscillations about equilibrium with correct SI units when k=2 N/m and m=8 kg.

T=________________________

(b) Suppose at t=0 the mass is at an amplitude which is seen to be 0.5m. Find the maximum velocity with correct SI units, again with k=2 N/m and m=8 kg.

V_{max}=______________________

(c) How long must a simple pendulum located near the surface of the earth be so that small oscillations about equilibrium have a frequency (f) of 0.5 Hz?

L=_________________________

(d) Suppose a system has an equation of motion given by $\frac{d^2x}{dt^2}+bx=0$ where b is a positive quantity. What is the frequency (ω) of small oscillations about equilibrium?

ω=_________________________

[3] A wire has a length L and is under a tension T and has a mass per unit length μ. For each of the sections below, you may assume L=4 m, T=50 N and μ=0.02 kg/m.

(a) Calculate the speed of a pulse on the wire.

v=________________________

(b) If the wire is plucked on one end, how long would it take for a pulse to **return**?

t=________________________

(c) Suppose for the same wire, one end is fixed and one end is free. Find the lowest frequency (f) of (standing) transverse oscillations.

f=______________________________

(d) Suppose both ends of the wire are fixed. Find the lowest frequency (f) of (standing) transverse oscillations.

f=___________________________

[4] An open and a closed organ pipe both have lengths of 3.5m. If the speed of sound is 343 m/s, find the following:

(a) Sketch the wave forms (of molecular displacement, Δs) for the lowest 3 modes of oscillations for the open pipe.

(b) Find the frequencies (f) of the lowest 3 modes of oscillations for the open pipe.

(c) Sketch the wave forms (of molecular displacement, Δs) for the lowest 3 modes of oscillations for the closed pipe.

(d) Find the frequencies (f) of the lowest 3 modes of oscillations for the closed pipe.