MA 226 Worksheet
Spring-mass systems

1.) Suppose a mass of 5kg is hung from a spring, and suppose the spring is stretched 1m by a force of 40N.
a.) Ignoring friction, find the position $x(t)$ of the mass at time t if the mass is pulled down an additional 2m down from equilibrium, and is sent moving upwards with an initial velocity of .5 m/s.
b.) Find the amplitude and phase of the oscillation.

2.) Suppose a mass of 1kg is hung from a spring, and suppose the spring is stretched 12cm by a force of 10N.
a.) Ignoring friction, find the position $x(t)$ of the mass at time t if the mass is pulled down an additional 3cm down from equilibrium, and is sent moving downwards with an initial velocity of 30 cm/s.
b.) Find the amplitude and phase of the oscillation.

3.) Suppose a mass of 1kg is hung from a spring, and suppose the spring is stretched 1m by a force of 10N. Also, suppose the system is submerged in a medium which imparts a resistance force of 25N when a mass moves 5 m/s.
a.) Find the position $x(t)$ of the mass at time t if the mass is pushed upwards .5m up from equilibrium, and is released from this position.
b.) How long should one wait until the oscillation is remains within 1cm of its rest position?

4.) Suppose a mass of 8kg is hung from a spring with spring constant 2 N/m. Also, suppose the system is submerged in a medium which imparts a resistance force of 32N when a mass moves 2 m/s.
a.) Find the position $x(t)$ of the mass at time t if the mass is knocked downwards with an initial velocity of 3m/s from its rest position.
b.) How long should one wait until the oscillation is remains within 1cm of its rest position? How many times does the mass pass through the equilibrium position?

5.) Suppose a 1kg mass is suspended from a spring with constant 25N/m, with no damping. Suppose you knock the mass from rest, with your goal being that the mass should be passing through the equilibrium position precisely one minute later. How fast should you knock the mass?

6.) Suppose a 3kg mass is suspended from a spring with constant 10N/m. You have a tunable "damper" which allows you to tune the resistance force against the motion of the mass. How strong (at the very least) should the damping be if your goal is to ensure that no motions cross the rest position more than once?

7.) Consider an undamped spring-mass system with mass m_0 and spring constant k. Suppose the mass is increased from m_0 to a slightly larger value m_1. Do you expect the frequency of oscillations to increase or decrease? What if the mass is kept at m and the spring is switched out with a stronger one, i.e. with a larger spring constant k_1?