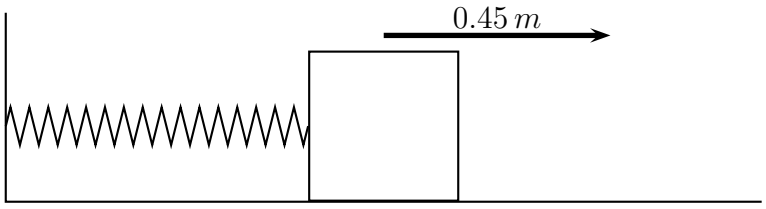
The final exam in physics 160 will consist of 15 multiple choice questions and one or two written questions. Five of the multiple choice and the written questions will be from the new material since exam #4. The remaining 10 multiple choice questions will be review questions and will be based on the multiple choice questions from the previous exams. You may expect problems from the following list of topics:

- Vector Addition
- Projectile Motion
- Newton's Second Law
- Conservation of Energy with Gravitational Potential Energy
- Conservation of Energy with Elastic Potential Energy
- Conservation of Momentum
- The relation between rotational and linear quantities
- Torque and Newton's Second Law for Rotation
- Conservation of Angular Momentum

Starting on the next page are practice problems for the new material.

1. A $2\,kg$ mass is attached to a $50\,N/m$ spring as shown below. The mass is pulled $0.45\,m$ to the right of its equilibrium position and then released from rest. There is no friction between the mass and the floor.



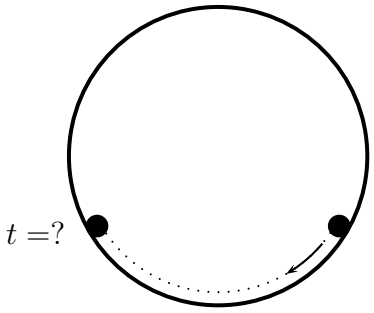
(a) What is the phase angle, ϕ, in the equation $x = A\cos(\omega t + \phi)$ for this motion?

(b) What is the amplitude of this motion?

(c) What is the period for this motion?

2. A periodic wave has a speed of $10\,m/s$ and $5\,m$ wavelength. What is the wave's period?

3. A small mass is started from rest one-third of the way up a frictionless circle of radius $2.45\,m$. How long does it take for the mass to slide to the other side? Assume this motion occurred on Earth. **HINT:** Compare the forces acting on this mass to the ones acting on the simple pendulum.



4. Through circumstances too bizarre to be detailed here, you find yourself marooned on an extrasolar, Earth-like planet!! In "honor" of Mastering Physics (whose psychological scars remain with you wherever you go), you christen your new home Planet Mongo.

   (a) Taking your Physics instructor's always excellent advice, you immediately measure the period of a simple pendulum. If you find that a $0.35\,m$ long pendulum has a $1.57\,s$ period, what is the acceleration due to gravity on Mongo?

(b) From data recovered from your wrecked spaceship, you determine that your vehicle's speed was $5860\,m/s$ when it entered Mongo's atmosphere (and was effectively a distance of one radius from Mongo's center). When your engines stopped working, your spaceship was traveling at $2500\,m/s$. Assuming you were infinitely far away from Mongo at this point (when gravity became the only force doing work on your spaceship), determine the mass and radius of your new home planet. **HINT:** You will need to use your result from part (a).

5. The most famous of comets is, of course, Halley's comet (mass $2.2 \times 10^{14}\, kg$). It orbits the sun (mass $1.99 \times 10^{30}\, kg$) with a period of $75.3\, years$ on a highly elliptical orbit of eccentricity 0.967.

   (a) Find the closest and farthest distance between the sun and Halley's comet, *i.e*, find the perihelion and aphelion distances.

(b) Find the speed of Halley's comet at perihelion and aphelion.