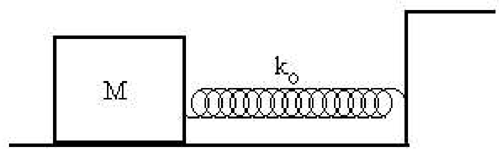
Sample Exam V

MULTIPLE CHOICE (4 pts each)

1) A mass M = 4 kg slides along a frictionless horizontal floor. At time = zero, it encounters a spring of constant k = 8 N/m. How long does it take the mass to come to rest?



A) 0 seconds
B) 0.2 seconds
C) 1.1 seconds
D) 35.8 seconds
E) 204.2 seconds

2) Consider a mass M oscillating at the end of a massless spring of constant k with amplitude A. At what distance(s) from the equilibrium point (x = 0) will the kinetic and potential energies be the same?

A) $x = 0$
B) $x = \pm 0.5A$
C) $x = \pm 0.71A$
D) $x = \pm A$
E) The K and the U_{SPRING} are never the same.

3) A fisherman notices that the wave crests on the water pass his anchored boat every 4 seconds. He measures the distance between crests to be 9 m. How fast are the waves traveling?

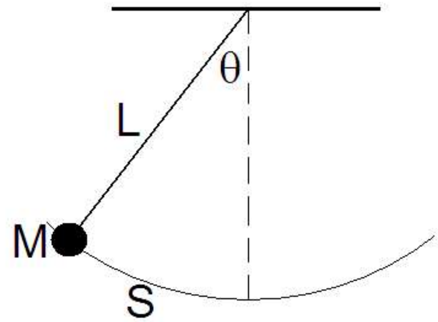
A) 0 m/s
B) 0.03 m/s
C) 0.44 m/s
D) 2.25 m/s
E) 36 m/s

4) Consider a particle oscillating with amplitude A. Through what distance does the particle move in one cycle? What is its displacement after one cycle?

A) distance = 0, displacement =2A
B) distance = 2A, displacement = 4A
C) distance = 4A, displacement = 0
D) distance = 0, displacement = 4A
E) distance = A, displacement = 0

5) The wail from an air-raid siren has an intensity of 1 Watt/m^2 at a distance of 1km. How far from the siren should you stand so that the intensity is only 0.01 Watt/m^2 ?

A) 0.01 km
B) 0.1 km
C) 1 km
D) 10 km
E) 100 km



PROBLEM I (20 pts)

Consider a simple pendulum of length L and mass M. Show that if the angle θ is kept small, the period of oscillation *P* is given by:

$$P = 2\pi\sqrt{\frac{L}{g}}$$

HINT: Compare the pendulum with a mass on a spring, for which the N II equation is

$$-kx = ma$$

and for which we have previously shown that

$$P = 2\pi\sqrt{\frac{m}{k}}.$$

PROBLEM II (20 pts)

In shallow water, the speed of a surface wave is given by the formula

$$v \approx \sqrt{gd},$$

where d is the depth of the water and g is the gravitational field strength. 'Shallow' is a relative term that means that the depth of water is much less than the wavelength of the wave, $d \ll \lambda$. This condition is met by *tsunami* waves in mid-ocean.

A) Estimate the speed of a *tsunami* in the open ocean, where the mean ocean depth is 5.6 km.

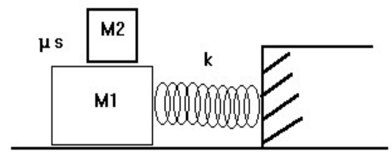
B) How long would it take such a wave to travel the approximately 9000 km from its source in, say, the mid-Pacific Ocean to, say, the California coast?

PROBLEM III (20 pts)

Suppose that you have a clock that operates on the motion of a mass on a spring and which keeps perfect time. Now, you take it with you when you vacation on Mars, where gravity is only one-third that on the earth. If you set your clock correctly at 12:00, what time will the clock read one hour later?

PROBLEM IIII (20 pts)

Consider a mass M_2 which sits upon a larger mass M_1, which in turn slides along a frictionless floor. M_1 is connected to a spring with constant k. The coëfficient of static friction between M_1 and M_2 is $\mu_S = 0.6$. With what maximum amplitude can M_1 oscillate back and forth without having M_2 slide off? HINT: Until the masses actually lose contact, you can treat them as if they were a single mass.



A) What type of force accelerates M_2 back and forth? (4 pts)

B) What is the maximum value this force can possibly have? (4 pts)

C) What is the maximum acceleration M_2 can experience without slipping? (4 pts)

D) Since M_2 hasn't slipped yet, we can still treat the two blocks as if they were one. Write Newton's second law for the motion of the combined blocks in the horizontal direction.? (4 pts)

E) Use the expression you found in Part D to find the maximum amplitude of oscillation so that M_2 does not slide. (4 pts)