

Physics 1C, Summer 2011 (Session 1)
Practice Midterm 1 (50+5 points)

Problem 1 (5+5 = 10 points)

A mass m at the end of a spring vibrates with a frequency of 0.88 Hz; when an additional 1.25 kg mass is added to m , the frequency is 0.48 Hz.

- a. What is the value of m ?
- b. What is the spring constant k ?

Problem 2 (4+4+4 = 12 points)

A 0.650-kg mass vibrates according to the equation $x = 0.25 \sin(5.50t)$, where x is in meters and t is in seconds.

- a. What is the period of the oscillations?
- b. What is the kinetic energy when x is 10cm?
- c. What is the potential energy when x is 10cm?

Problem 3 (5+5 = 10 points)

Suppose you produce two sound waves from the same source: the first wave has a period of 0.500 ms, and the second wave has a period of 0.520 ms. When you stand 1 meter away from the source, the intensity of each wave by itself is 50 dB.

- a. What is the beat frequency caused by the two waves?
- b. Assuming each source emits sound isotropically (in all directions equally), what is the intensity of each wave in dB if you stand 2 meters away from the source?

Problem 4 (4+4 = 8 points)

Echolocation is a form of sensory perception used by animals such as bats, toothed whales and porpoises. The animal emits a pulse of sound (a longitudinal wave) which is reflected from objects; the reflected pulse is detected by the animal. Echolocation waves emitted by whales have frequencies of about 200,000 Hz.

- a. What is the wavelength of the whale's echolocation wave, given that the bulk modulus of water is $2.0 \times 10^9 \text{ N/m}^2$?
- b. If an obstacle is 100 m from the whale, how long after the whale emits a wave will the reflected wave return to him?

Problem 5 (5+5 = 10 points)

A bat flies toward a wall at a speed of 5.0 m/s. As it flies, the bat emits an ultrasonic sound wave with frequency 30.0 kHz. The speed of sound in air is 343 m/s.

- a. What is the frequency of the sound wave as received by the wall?
- b. What frequency does the bat hear in the reflected wave?

Extra Credit (3+2 = 5 points)

A damped harmonic oscillator loses 5.0 percent of its mechanical energy per cycle.

- a. By what percentage does its frequency differ from the natural frequency, $\omega_0 = \text{Sqrt}[k/m]$?
- b. After how many periods will the amplitude have decreased to $1/e$ of its original value?