PHYSICS 232 – TEST # 1

NAME:

STUDENT ID #:

USEFUL FORMULAS

Periodic motion

$$f = \frac{1}{T} \quad , \quad \omega = 2\pi f$$

Spring:

$$F = -kx \ , \qquad \omega = \sqrt{\frac{k}{m}}$$

Conservation of Energy:

$$E = \frac{1}{2}mv^2 + \frac{1}{2}m\omega^2 x^2 = \frac{1}{2}m\omega^2 A^2$$

Simple Pendulum:

$$\omega = \sqrt{\frac{g}{L}}$$

Damping force $F = -bv$, damped oscillation

$$x = Ae^{-bt/(2m)} \cos\sqrt{\frac{k}{m} - \frac{b^2}{4m^2}}\, t$$

Driving force of frequency ω_0, resonance:

$$A = \frac{F_{max}}{\sqrt{(k - m\omega_0^2)^2 + b^2\omega_0^2}}$$

Mechanical waves

$$v = \lambda f = \frac{\omega}{k} = \sqrt{\frac{F}{\mu}} \quad , \qquad k = \frac{2\pi}{\lambda}$$

Average power: $P_{av} = \frac{1}{2}\sqrt{\mu F}\omega^2 A^2$
Standing wave:

$$y(x,t) = A_{sw} \sin kx \ \cos \omega t$$

On a string of length L with both ends fixed,

$$f_n = n\,\frac{v}{2L} = nf_1, \quad (n = 1, 2, 3, \dots)$$

Sound

Pressure amplitude: $p_{max} = BkA$
Speed:

$$v = \sqrt{\frac{B}{\rho}} \ \text{(fluid)}, \quad \sqrt{\frac{Y}{\rho}} \ \text{(solid rod)},$$

$$v = \sqrt{\frac{\gamma p}{\rho}} = \sqrt{\frac{\gamma RT}{M}} \ \text{(ideal gas)}$$

Intensity:

$$I = \frac{p_{max}^2}{2\rho v} = \frac{\text{total power}}{4\pi r^2}$$

Sound intensity level:

$$\beta = (10dB)\log\frac{I}{I_o} \ , \qquad I_o = 10^{-12}\text{W/m}^2$$

Pipe open at both ends,

$$f_n = \frac{nv}{2L} \quad (n = 1, 2, 3, \dots)$$

Pipe open at one end and closed at the other (stopped pipe),

$$f_n = \frac{nv}{4L} \quad (n = 1, 3, 5, \dots)$$

Beat frequency ($f_a > f_b$):

$$f_{beat} = f_a - f_b$$

The Doppler effect (S: source, L: listener):

$$f_L = \frac{v + v_L}{v + v_S} f_S$$

Source moving with speed $v_S > v$:

$$\sin\alpha = \frac{v}{v_S}$$

There are four (4) problems in this test. Make sure you answer all questions in each problem for full credit. Show as much of your work as possible to receive partial credit, in case you don't come up with the right answer. Good luck!

George Siopsis - 9/13/05

Problem 1

(a) If a pendulum clock is taken to a mountaintop, does it gain or lose time, assuming it is correct at a lower elevation? *Explain your answer.*

(b) A musical interval of an octave corresponds to a factor of two in frequency. By what factor must the tension in a guitar or violin string be increased to raise its pitch one octave? To raise it two octaves?

(c) If the pressure amplitude of a sound wave is halved, by what factor does the intensity of the wave decrease? *Explain.*

Problem 2

A 0.85 kg body vibrates according to the equation

$$x = 0.65\ \cos(5.2t)$$

where x is in meters and t is in seconds. Determine

(a) the amplitude, frequency and period

(b) the maximum speed and maximum acceleration

(c) the kinetic energy and potential energy when $x = 0.45$ m.

Problem 3

A pipe, 80 m long and 15 cm in diameter contains olive oil of density 918 kg/m^3 and bulk modulus 1.6×10^9 Pa. A 8.5 Hz longitudinal wave is transmitted in the oil.

(a) Calculate the time it takes for the wave to travel the length of the pipe.

(b) What is the wavelength of the wave?

(c) If the amplitude is 2.5 mm, what is the intensity of the wave?

Problem 4

An enclosed chamber with sound absorbing walls has a 2.5 m $\times$ 0.75 m opening for an outside window. A loudspeaker is located outdoors, 25 m away and facing the window. The intensity level of the sound entering the window space from the loudspeaker is 65 dB. Assume the acoustic output of the loudspeaker is uniform in all directions and that acoustic energy incident upon the ground is completely absorbed.

(a) What is the acoustic power entering through the window space?

(b) What is the sound intensity at a point midway between the loudspeaker and the window?

(c) What is the acoustic power output of the loudspeaker?