

Name: \_\_\_\_\_

**PHYS 2211 – Exam 4**  
**April 16, 2008**

*Please solve all five problems below. You must **show all your work** to get full credit. You may use a calculator and a 3" x 5" index card for reference. A cell phone may not be used as a calculator. Exam duration: 55 min.*

1. A pendulum has a period of 0.670 s on Earth. It is taken to another planet and found to have a period of 0.816 s. The change in the pendulum's length is negligible.
- (a) Is the gravitational field strength on the other planet greater than or less than that on Earth? [ $g_{\text{planet}} > g_{\text{Earth}}$ ]
- (b) Find the gravitational field strength on the other planet. [6.61 m/s<sup>2</sup>]

2. A cart with mass  $m$  is attached between two ideal springs, one with spring constant  $k$ , the other with spring constant  $3k$ . Assume that the cart can oscillate without friction.



- (a) When the cart is displaced by a small distance  $x$  from its equilibrium position, what force magnitude acts on the cart? (Express your answer in terms of  $k$  and  $x$ .) [ $F = 4kx$ ]
- (b) What is the angular frequency, in terms of  $m$ ,  $x$ , and  $k$ , for this cart? [ $\omega = \sqrt{\frac{4k}{m}}$ ]
- (c) When the cart is empty, it oscillates with  $\omega = 10.5$  rad/s. A load is placed in the cart, making the total mass 3.9 times what it was before. What is the new value of  $\omega$ ? [5.32 rad/s]

3. The equation of a transverse wave traveling along a very long string is given by

$$y(x,t) = 6.9 \sin[(0.026\pi)x + (4.2\pi)t],$$

where  $x$  and  $y$  are expressed in centimeters and  $t$  is in seconds. Determine the following:

(a) the amplitude [6.9 cm]

(b) the wavelength [76.9 cm]

(c) the frequency [2.1 Hz]

(d) the speed [162 cm/s]

(e) the direction of propagation of the wave [negative x direction]

(f) the maximum transverse speed of a particle in the string [91 cm/s]

(g) What is the transverse displacement at  $x = 3.5$  cm when  $t = 0.26$  s? [-3.75 cm]

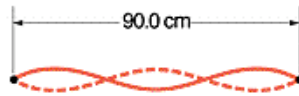
4. Two sinusoidal waves, identical except for phase, travel in the same direction along a string and interfere to produce a resultant wave given by

$$y'(x,t) = (1.0\text{mm})\sin(27x - 4.0t + 0.960\text{rad}),$$

with  $x$  in meters and  $t$  in seconds.

- (a) What is the wavelength,  $\lambda$ , of the two waves? [0.23 m]
- (b) What is the phase difference between the two waves? [1.92 rad]
- (c) What is their amplitude  $Y$ ? [0.872 mm]

5. A nylon guitar string has a linear density of 7.5 g/m and is under a tension of 150 N. The fixed supports are 90 cm apart. The string is oscillating in the standing wave pattern shown in the figure below.



Calculate the following values of the traveling waves whose superposition gives this standing wave.

- (a) speed [141 m/s]
- (b) wavelength [60 cm]
- (c) frequency [235 Hz]