Physics 312   PM   Name ______________________
13 Oct 2003

Test 2   Table ______________

This exam counts 100 points.

Remember:

Show all your work for full credit. Minimum of **4** steps:

- **Draw a diagram !!**
- What equation are you plugging into?
- What numbers are you substituting?
- What is your final answer?

Ask if anything seems unclear.

Vectors have **magnitude** and **direction !** or **two** components **!**

Formulae and Constants: Note: **bold** means vector!

$g = 9.80\ m/s^2 = 980\ cm/s^2$ $G = 6.67 \times 10^{-11}\ N \cdot m^2/kg^2$

$f_k = \mu_k F_N$ $f_s \le \mu_s F_N$ $a_c = a_{radial} = v^2 / r$ $F = GM_1 m_2 / r^2$

$W = \int \vec{F} \cdot d\vec{r} = -U$ $\text{Impulse} = \int \vec{F}\, dt = \Delta \vec{p}$ $F_x = -dU/dx$

$K = {}^1/_2\, mv^2$

$\vec{p} = m\vec{v}$ **F** = d**p**/dt $\vec{\tau} = \vec{r} \times \vec{F} = r F \sin\theta$ $\tau = r_\perp F = r F_\perp$

$\vec{\ell} = \vec{r} \times \vec{p}$ $I = \Sigma m r^2 = \int r^2 dm$ $I = I_{cm} + M h^2$

stress = F/A   strain = ΔL/L   stress = (modulus)(strain)

$\omega_{spring} = \sqrt{\frac{k}{m}}$ $\omega_{pend} = \sqrt{\frac{g}{L}}$ $\omega_{other} = \sqrt{\frac{"K"}{I}}$ $v_{string} = \sqrt{\frac{F_T}{\mu}}$

$x = x_m \cos(\omega t + \varphi_0)$ $U_{spr} = {}^1/_2\, kx^2$ $F_{spring} = -kx$

$P = \frac{1}{2}\mu v \omega^2 y_m^2 = \text{constant} * y_m^2$ $y = A \sin[k x - \omega t]$ $v = \lambda f = \omega / k$

Page

1. __________/

2. __________/

3. __________/

4. __________/

1. (7 points)

(a) One version of Newton's Second Law says $\sum \vec{F} = \frac{d\vec{p}}{dt}$

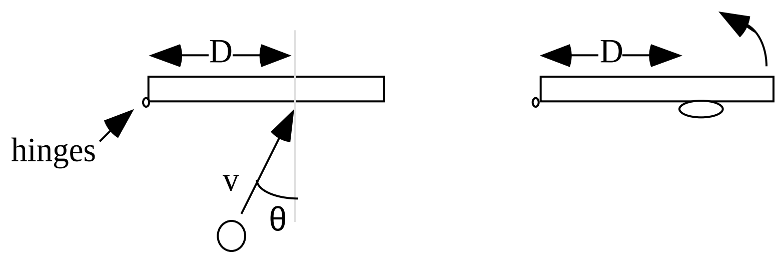
By analogy, write down the equivalent rotational version of Newton's Second Law in the box.

(b) Under what general circumstances is angular momentum conserved?

2. (8 points) Imagine that you stand on a stationary platform (which can rotate about a vertical axis with frictionless bearings) holding a rotating bicycle wheel whose axis of rotation is vertical and which is rotating CW. You twist the wheel axis from vertical to horizontal. What happens to you? **Why?** Be specific.

3. (15 points) An open door of mass M = 35.0 kg is hung on frictionless hinges; the moment of inertia of the door about its hinges is 6.22 kg•m^2. The door is at rest when it is struck by a ball of putty of mass m = 1.10 kg (!) at a point a distance D = 0.625 m from the hinges. Just before the ball hits the door, its path is horizontal and makes an angle θ = 0.38 rad as shown, and its speed is v = 27.0 m/s. The putty sticks to the door after the collision.

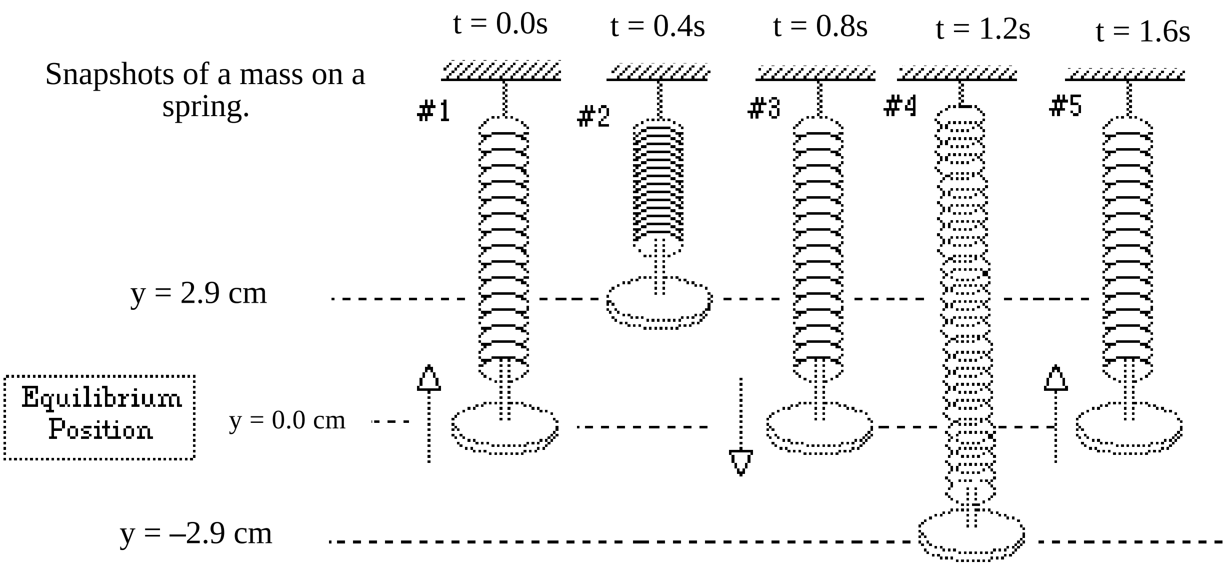
(a) Explain why linear momentum of this system is **not** conserved.



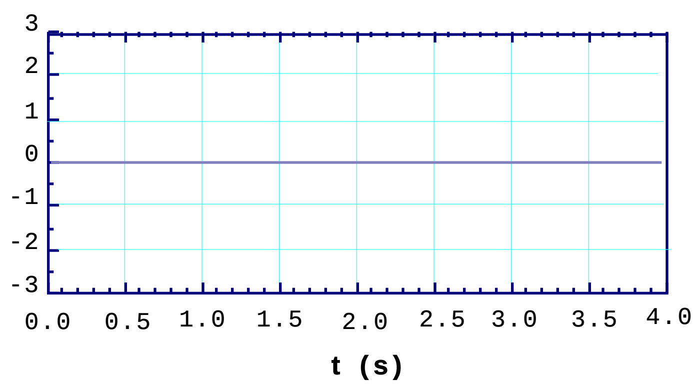
(b) Calculate the rotational speed of the door after the collision.

(c) This collision is (circle one): **elastic** **inelastic** **completely inelastic**

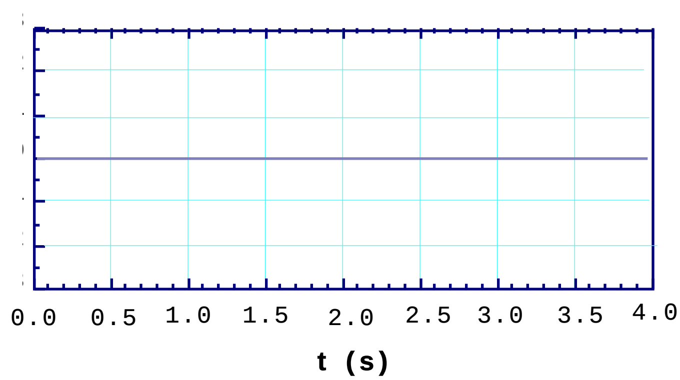
4. (40 points) A mass (m = 300.0 g) on a spring is oscillating with simple harmonic motion. The mass is moving in the direction indicated by the arrow but has no displacement at the moment the observer starts timing it (i.e. x = 0.0 cm at t =0.0 s). Snapshots of the displacements of the mass at various times are shown in the diagram below. The arrows in the diagram show the direction of the velocity of the mass in snapshots #1, 3, and 5. Neglect the mass of the spring.



(a) Sketch a graph of the displacement of the spring from its equilibrium position in centimeters for times between 0.0 s and 4.0 s. (**Always label graph axes!)**



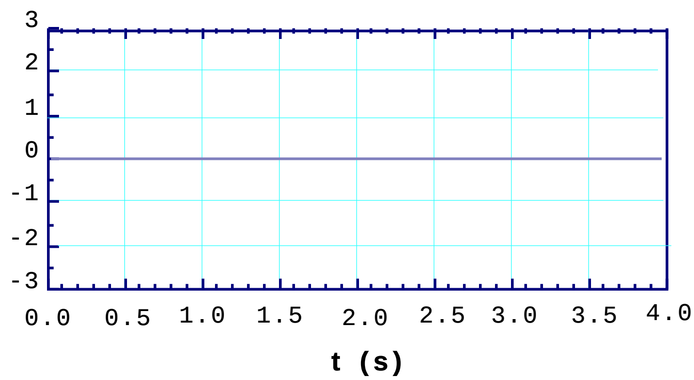
(b) Sketch a graph of the **velocity** of the mass:



(c) Determine the total mechanical energy of the mass/spring system in snapshot #1. Determine the total mechanical energy of the mass/spring system in snapshot #2. Clearly show your calculations or explain your reasoning.

(d) What are the velocities of the mass in snapshots #2 and #4?

(e) Suppose we use the same spring as shown above, but with half the mass on it. We pull the mass up to y = +2.9 cm and release it at t = 0.0s. Sketch a graph of the displacement:



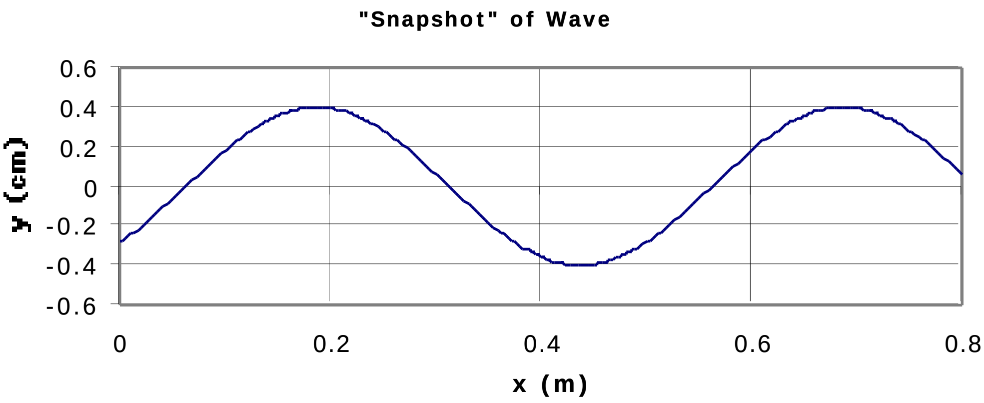
(f) Determine the values and units of the numbers you need to specify the for the oscillation, and fill in the blanks in the equation for the oscillation (for the new mass you used in part (e)):

y(t) = **cos** [t]

5. (5 points) In simple harmonic motion: (circle all that apply)

A. the acceleration is constant.
B. the velocity is greatest at the maximum displacement.
C. the period depends on the amplitude.
D. the acceleration is greatest at zero displacement.
E. the acceleration is greatest when the velocity is zero.

6. (25 points) A snapshot of a wave on a string at time t = 0 is shown below. The wave is traveling to the right with velocity v. The tension in the string is 4.00 N and the mass density is μ=0.0030 kg/m.



Find the following values (and units):

(a) amplitude = ____________________ (b) wavelength = ____________________

(c) angular frequency = ________________ (d) initial phase = ___________________

(e) Determine the speed of the wave.

(f) Write an equation for the wave, substituting all appropriate quantities from above.

(g) Calculate the transverse velocity of the string at the point x = 0.4 m at time t = 0.6 s.

The tension in the string is decreased by a factor of 4; nothing else is changed. What happens to

(h) the wave speed

(i) the wavelength

(j) the angular frequency of the traveling wave