Problem Set VIII- Assign November 1, 2006 Due November 8, 2006.
Fall 2006 Physics 200a
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1. Problem 5.2.4 from Basic Training in Mathematics
2. Problem 5.3.2 from BTM. (Do just first part, i.e, just first pair of z_1 and z_2.)
3. Problem 5.3.3 from BTM
4. Problem 5.3.6 from BTM
5. Consider a particle attached to a spring executing a motion $x = A\sin(\omega t + \delta)$ with $A = .32\ m$. At $t = 0$, it is at $x = -.07m$ and a velocity $-2m/s$. The total energy is $5.6J$. Find (i) δ, (ii) f the frequency, (iii) k and (iv) m.
6. A mass m moving horizontally at velocity v_0 on a frictionless table strikes a spring of force constant k. It compresses the spring and then bounces back with opposite velocity. Assuming no loss of energy anywhere find out (i) how long the mass is in contact with the spring and (ii) the maximum compression of the spring.
7. A steel beam of mass M and length L is suspended at its midpoint by a cable and executes torsional oscillations. If two masses m are now attached to either end of the beam and this reduces the frequency by 10%, what is m/M?
8. Imagine a solid disc, (say a penny,as in Fig (**??**), of mass M, radius R, standing vertically on a table. A tiny mass m of negligible size is now glued to the rim at the lowest point. When disturbed, the penny rocks back and forth without slipping. Show that the period of the Simple Harmonic Motion is

$$T = 2\pi\sqrt{\frac{3MR}{2mg}}.$$

   Hint: Find κ, the restoring torque per unit angular displacement. When $m \to 0$ what happens to T. Explain in physical terms.

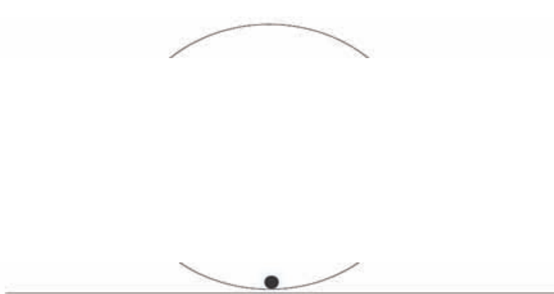

FIG. 1. The disc has mass M, radius R and is standing on a table where it rolls without slipping. The tiny dot at the bottom has no size and a mass m.

9. I am driving my car on a parkway which has bumps every 30 m apart. At what speed must I be driving to experience violent shaking if the suspension in my car has a resonant frequency of 0.5 Hz?

For following problems the symbols are defined the following equations

$$m\frac{d^2x}{dt^2} + b\frac{dx}{dt} + kx = F_0 \cos(\omega t)$$

$$\omega_0 = \sqrt{\frac{k}{m}}$$

10. Show that a driven oscillator has its maximum amplitude of vibration at a frequency $\omega = \sqrt{\omega_0^2 - (b^2/2m^2)}$. At what frequency does the velocity have the greatest amplitude?

11. For a damped oscillator (not driven by any external force) find the time T^* after which the amplitude of oscillations drops to half its value in terms of b and m.

12. Consider a damped oscillator with $k = 32, m = .5, b = 1$ in MKS units.
(i) Find the solution with $x(0) = 2, v(0) = 0$. I suggest using symbols till the every end.
(ii) Now add on a driving force $F_0 \cos \omega t$ with $F_0 = 10N$ and $\omega = 2\omega_0$. Find the solution with $x(0) = 2, v(0) = 0$.