Physics 321
Exam 1 Sample Questions

1. Write the second order differential equation $\frac{d^2y}{dx^2} = A\sin(x)\frac{dy}{dx} + B\cos(x)$ as two first order differential equations. Write a set of boundary equations that could be used to solve the equations numerically. (There is no unique set of boundary conditions that must be chosen, of course.)

2. We know that $\frac{dy}{dx} = 3x^2$. Using a step size $\Delta x = 0.10$, fill out the following table.

x	*y*
0	0
0.1	

3. State Newton's three laws of motion. Briefly explain the meaning of each law.

4. Describe one case where Newton's third law does not hold.

5. You are given the following problem:
A ladder leaning against a wall starts to slide. Find the motion of the ladder using forces and Newton's second law. Explain how you would solve this problem. Be specific enough that I could follow your steps to complete the problem.

6. After starting a bicycle tire spinning by hand, some mud flies off the outside edge of the tire. What happens to the angular speed of the tire after the mud leaves.? Why?

7. A suitcase contains a spinning flywheel with its axis horizontal. What happens to the suitcase when you walk around a corner? Explain why.

8. A cylinder and a sphere of the same mass and diameter are allowed to roll down an inclined plane without slipping. Which reaches the bottom first? Why?

9. Describe two methods we use to obtain differential equations by using conservation of energy.

10. Describe the three types of harmonic oscillator damping. Write the differential equation for a damped harmonic oscillator. How is β related to ω_0 for each case?

11. An underdamped harmonic oscillator is characterized by a certain β and ω_0. What is the time constant for the damping (the time it takes the amplitude to decrease by $1/e$)? At what frequency does the system oscillate? Hint: e^{rt}.

12. A driven harmonic oscillator has a natural frequency ω_0 and is driven at a frequency $\omega = 3\ \omega_0$. Describe the frequency of the system's oscillations as a function of time including transients and the steady-state solution.

13. Sketch the response A^2 of a driven harmonic oscillator as a function of the driving frequency ω. At what frequency is the response a maximum? What does FWHM mean? What is the expression we use for the FWHM for A^2 ?

14. Define the Q value of a damped harmonic oscillator (not driven), and of a driven harmonic oscillator. How is Q related to β?

15. Considering drag forces, in what circumstances does linear damping dominate? quadratic damping?

16. Write down the equations for the motion of a baseball in two dimensions. Include linear and quadratic drag terms.

17. What is the Lorentz force? What is the general motion of a charged particle moving in a constant B field?

18. Derive expressions for the cyclotron radius and the cyclotron frequency. (The radius and frequency for charged particles that move in circular orbits in constant B fields.)