Physics 234-102 (Wednesday Class) Final Exam, 5/5/03
Due in Physics Office by 12 noon on May 12th
Attach solutions to exam sheets and show all work
Work alone!

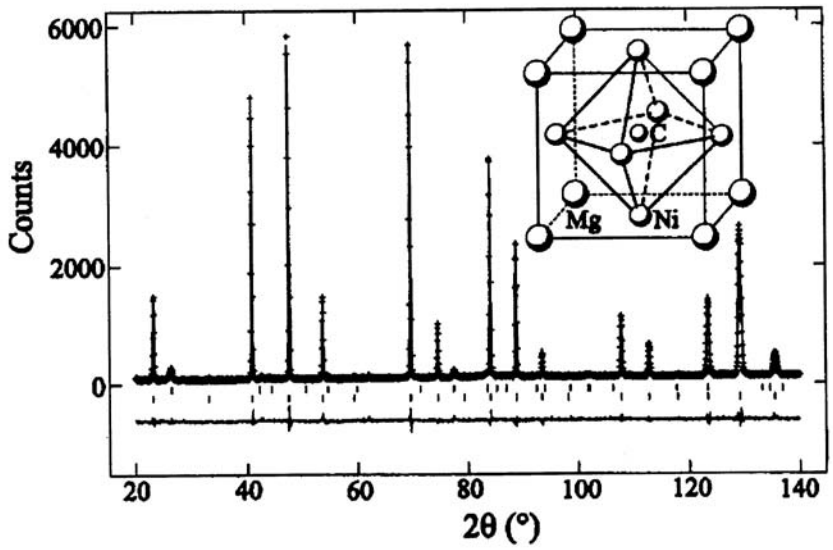
Name:_____

1. (15 pts.) The end of one of the prongs of a tuning fork that executes simple harmonic motion of frequency 1000 Hz has an amplitude of 0.40 mm. Find (a) the magnitude of the maximum acceleration and (b) the maximum speed of the end of the prong. Find (c) the magnitude of the acceleration and (d) the speed of the end of the prong when the end has a displacement of 0.20 mm.

2. (10 pts.) A string 4.0 m long has a mass of 3.0 g. One end is attached to a wall and the other hangs over a pulley and is attached to a 2 Kg mass. What is the speed to the transverse wave in the horizontal section of the string?

3. (15 pts.) A girl is sitting near the open window of a train that is moving at a velocity of 10.00 m/s to the east. The girl's uncle stands near the tracks and watches the train move away. The locomotive whistle emits sound at frequency 500.0 Hz. The air is still. (a) What frequency does the uncle hear? (b) What frequency does the girl hear? A wind begins to blow from the east at 10.00 m/s. (c) What frequency does the uncle now hear? (d) What frequency does the girl now hear?

4. (15 pts.) Nuclear reactors are used as sources of neutron for diffraction experiments. The neutron diffraction pattern from $MgCNi_3$ for neutron of wavelength 0.154 nm is shown below. Estimate the d-spacings revealed in this pattern and give the kinetic energy of the neutron used in the experiment.



5. (15 pts.) Four waves (below) are sent along a string in the same direction. What is the resultant wave?

$y_1(x,t) = 5 \sin(kx - \omega t)$

$y_2(x,t) = 6 \sin(kx - \omega t - \pi/2)$

$y_3(x,t) = 3 \sin(kx - \omega t + \pi/3)$

$y_4(x,t) = 2 \sin(kx - \omega t + \pi)$

6. (15 pts). Data for the stopping potential vs. wavelength for the photoelectric effect in sodium are give by the table below. What are the (a) work function, (b) threshold frequency, (c) ratio h/e.

Wavelength (nm)	200	300	400	500	600
V (volts)	4.2	2.06	1.05	0.41	0.03

7. (15 pts.) An x-ray photon of wavelength 6 pm makes a head on collision with an electron so that it is scattered by an angle of 180°. (a) What is the change in the wavelength of the photon? (b) What is the energy lost by the photon? (c) What is the kinetic energy of the scattered electron.

8. (20 pts). An electromagnetic wave is traveling in vacuum and has magnetic field given by

$\mathbf{B}(z,t) = 10^{-8} \cos(6z - 5\, t)\, \mathbf{i}$

(a) What are the direction of propagation, wavelength and frequency of the wave. (b) Find the expression for the electric field. (c) Find the Poynting vector. (d) Find the average intensity. (d) Find the force exerted on a 1 m^2 sheet by absorption of this light.

9. (20 pts). An electron is confined to a rectangular region defined by Lx= 200 pm and Ly = 800 pm with one corner at the origin. (a) Find the ground state energy (b) Find the wavelength of the photon need to excite the electron the first excited state. (c) Show that the function

$\psi_{nx\,ny}(x,y) = A \sin(n_x \pi x/L_x) \sin(n_y \pi y/L_y)$

is the solution of Schrödinger's equation for this problem and find A. (d) Plot the probability density in the x-y plane for the ground state and second excited state. (e) Compute the average value of x and the average value of y in the ground state.

10. (10 pts. bonus) For hydrogen in the 2s (excited) state the radial probability density is

$P(r) = r^2/ (8)(2 – r/a)^2 e^{-r/a}$

What is the probability of finding the electron between 0 and 1.5a ? Compare the result to that for the ground state ($P(r) = 4/a^3 r^2 e^{-2r/a}$) and comment on the change in the electron distribution which occurs on going from the ground state to the first excited state.