Assignment 1 Weeks 1-2

Review class notes and Chapters 1 and 2 from the book. The homework is due in class on Tuesday January 20th.

1. This question deals with the photoelectric effect experiment. [30 points]
(a) Provide a sketch of the apparatus. What information is collected and how does it tell you about the kinetic energy of emitted electrons.
(b) State the observations made in the experiment.
(c) Imagine that light acted like a wave in the photoelectric effect experiment. Draw two plots that would describe possible experimental results. (I am looking for plots – written explanations will not get you any points)
[Note: you should ask yourself such questions for each of the experiments discussed in Lectures 2]
(d) The following data were observed in an experiment on the photoelectric effect from potassium:

10^{19}Kinetic Energy (J)	4.49	3.09	1.89	1.34	0.700	0.311
Wavelength (nm)	250	300	350	400	450	500

Graphically evaluate these data to obtain values for the work function and Planck's constant.
(e) The work function of platinum is 5.65 eV. What is the minimum frequency of light required to observe the photoelectric effect on Pt? If light with a 150-nm wavelength is absorbed by the surface, what is the maximum velocity of the emitted electrons?

2. Consider a system that can exist in two energetic states, ε_1 and ε_2. Assume that the degeneracy of each state is 1 and that the temperature is 298 K. Use Boltzmann distribution to calculate the fraction of population in the upper state if $\Delta\varepsilon = \varepsilon_2 - \varepsilon_1$ is: [10 points]
(a) $\Delta\varepsilon$ =10 GHz (typical of a molecule's rotational energy level spacing)
(b) $\Delta\varepsilon$ = 2000 cm^{-1} (typical of a molecule's vibrational energy level spacing)
(c) $\Delta\varepsilon$ = 3 eV (typical of a molecule's electronic energy level spacing)
(d) $\Delta\varepsilon$ = 500 MHz (typical of transition involved in proton – NMR)

3. Determine in each of the following cases if the function in the first column is an eigenfunction of the operator in the second column. If so, what is the eigenvalue? [10 points]

a.	x^3	$d^3/\ dx^3$
b.	$x\,y$	$x(\partial/\partial x)+y(\partial/\partial y)$
c.	$\sin\theta\ \cos\theta$	$\partial^2/\partial\theta^2$
d.	e^{-kx}	$\partial^2/\partial x^2$

4. Find the result of operating with $\frac{1}{r^2}\frac{d}{dr}r^2\frac{d}{dr}+\frac{2}{r}$ on the function Ae^{-br}. What must the values of *A* and *b* be to make this function an eigenfunction of the operator? [20 points]

5. Distinguish between the following terms applied to a set of functions: orthogonal, normalized000179129 [10 points]

6. Determine N such that the function N sin(nπx/a) is normalized over the spatial range of $0 \le x \le a$. Is this function orthogonal? [20 points]