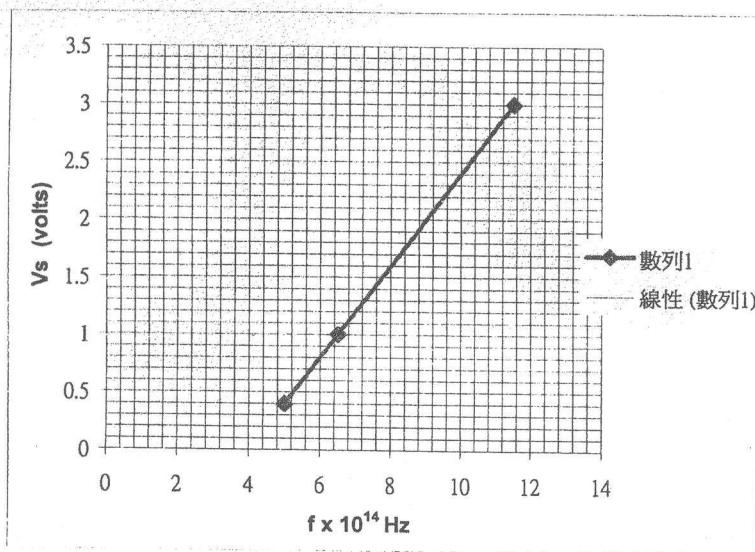


1. The wave function $\psi(x) = ce^{-\alpha x^2}$ describes a state of the quantum oscillator, provided the constant α is chosen appropriately. (a) Using Schrodinger's equation, obtain an expression for α in terms of the oscillator mass m and the classical frequency of vibration ω . What is the energy of this state? (12%) (b) Normalize this wave function. (8%)

2. A two-slit electron diffraction experiment is done with slits of unequal widths. When only slit 1 is open, the number of electron reaching the screen per second is 25 times of the number of electrons reaching the screen per second when only slit 2 is open. When both slits are open, an interference pattern results in which the destructive interference is not complete. (a) Find the ratio of the probability of an electron arriving at an interference maximum to the probability of an electron arriving at an adjacent minimum. (10%) (b) Explain why the interference pattern can be obtained, when both slits are opened at the same time. (5%)

3. Figure in below shows the stopping potential versus incident photon frequency for the photoelectric effect for sodium. Use these data points to find (a) the work function, (5%) (b) the ratio between Plank's constant and electron charge h/e , (5%) (c) the cutoff wavelength. (5%)



4. Explain the following items:

- First Brillouin zone (5%)
- Optical branch and acoustical branch (5%)
- Surface plasmons and interface plasmons (5%)
- p-type semiconductor (5%)
- Hall effect (5%)
- Bloch function (5%)

5. In the H_2^+ molecular ion, sketch E_s (electron energy) and U_p (electron potential energy) as functions of nuclear separation R for the symmetric and antisymmetric states. And brief explain the comparison between each curves. (10%)

6. A particle of total energy $8V_0$ is incident from $-x$ axis on a potential given by

$$V = \begin{cases} 6V_0, & x < 0 \\ 0, & 0 < x < a/2 \\ 3V_0, & x > a/2 \end{cases}. \text{ Find the probability that the particle will be transmitted}$$

through to the positive side of the x axis, $x > a/2$. (10%)

