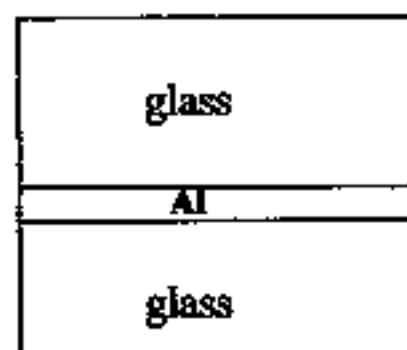


- (10 points) (a) Explain why the number of lines in the absorption spectrum of sodium vapor is different from that of emission spectrum? (b) Why are the absorption lines never completely dark?
- (10 points) (a) The probability density for $n=0$ of a quantum-mechanical harmonic oscillator is different from that of classical oscillator, but the probability densities for $n=20$ are quite similar for both cases. Why?
- (10 points) (a) Given an unknown thin films grown on Si wafer, what information of the film properties can you get from Rutherford back scattering experiment? (b) Given a characteristic x-ray source, how do you determine the x-ray wavelength by experiments?
- (20 points) The multilayer is made of glass(5000 nm) /Al (1 nm)/glass (5000 nm). We shine a light with a wavelength of 450 nm into the multilayer. Will you detect any transmission light in the photo detector? You can ignore the absorption in glass. Please use Schrodinger's equation to analyze this situation. When you change the wavelength of light or the thickness of Al, how does the intensity of transmission light vary with the changes?



5. We put 11 electrons in an infinite one-dimensional potential well of size L .
- (a) What are the possible energy values of the electrons? (10 points)
 - (b) Where is the position of Fermi level at 0 K? (5 points)
 - (c) What is the possibility of exciting the topmost electron to the first excited state at a temperature T above 0 K? (10 points)
6. Using simplified band diagrams explain when a crystalline solid can be regarded as a metal, semiconductor, or insulator. (15 points)
7. Experimentally the addition of impurities to metals increases their resistivity, but the addition of impurities to semiconductors usually decreases their resistivity. Explain. Many insulators, however, are not very pure. Why do impurities not affect the resistivity of insulators? (10 points)