EE 5621 **QUIZ 1** **S. G. Burns**
17 September 2021

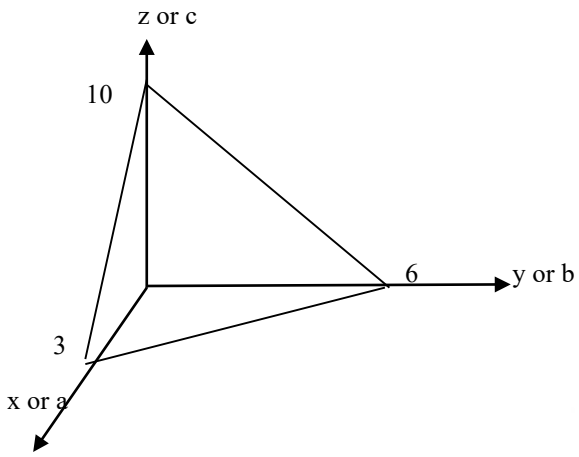
Name:_____

All quizzes are open book, open notes, open WEB (but watch your time management). Be sure your name is on any extra sheets. Submit pdf, WORD, jpg, scan, etc. to sburns@d.umn.edu Be sure your name is on any additional sheets.

Problem 1 (20 Points; 10 Points Each) Crystallography

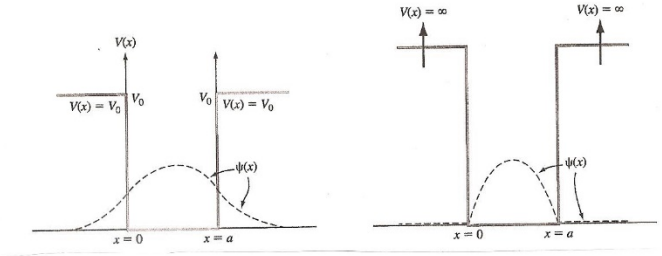
(a) The Si unit cell is of the form of a (**Cubic, FCC, Diamond, BCC, Zincblende**) and has (**2, 4. 6, 8, 10, 12**) atoms with a lattice spacing of (**5.65Å, 4.08Å, 5.43Å, 10.0Å**) yielding about _____Si atoms/cm^3)

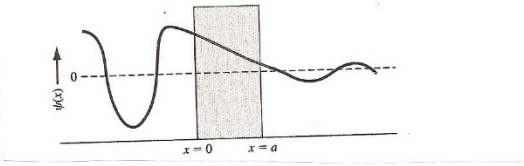
(b) Compute the Miller indices for the crystal plane shown in the figure.

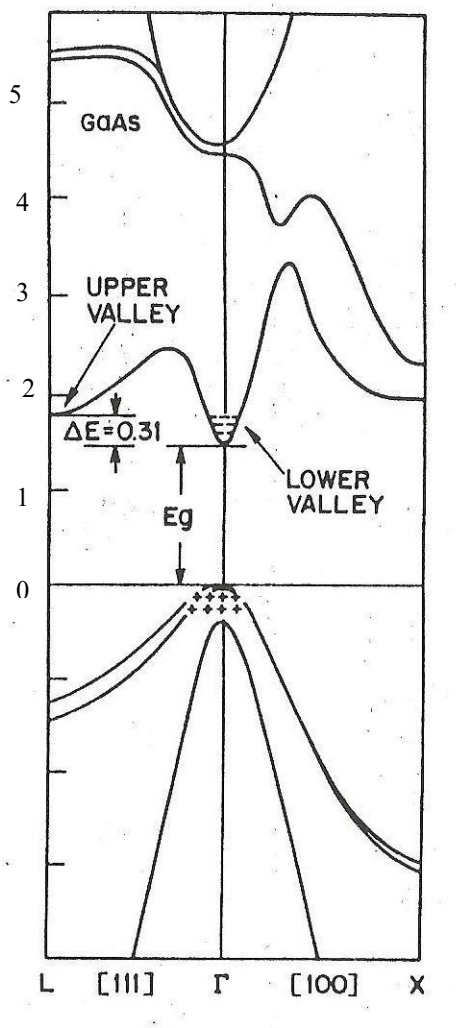


Problem 2 (15 Points)

The figure shows solutions for $\psi(x)$ for three different sets of boundary conditions. For a single electron, provide a value for $\int_{-\infty}^{\infty} \psi(x)\,\psi(x)^* dx$ = _____ **and interpret the results in a sentence or two.**







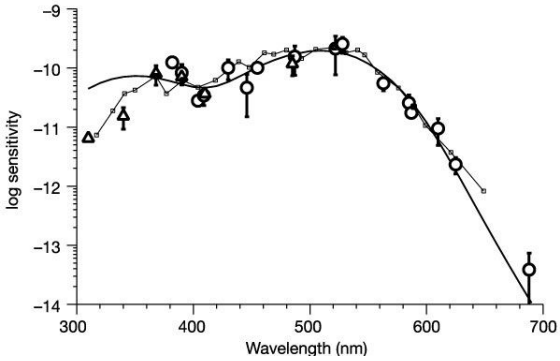
Problem 3 (30 Points) This is an energy band diagram for GaAs. The vertical scale is in eV.

(a) (10 Points) There is a 50% probability that an electron is located at the Fermi Level when the Fermi Level is located at E = 0.72 eV. The center of the energy gap. (**TRUE, FALSE**). Careful-trick question alert! Circle your choice.

(b) (10 Points) GaAs is considered to be a (**DIRECT, INDIRECT**) semiconductor whereas Si is considered to be a (**DIRECT, INDIRECT)** semiconductor. Circle your choices.

(c) (10 Points) Qualitatively compare the probability of an electron populating the "upper valley" state compared to the lower valley state.

Problem 4 (35 Points) The Spectral sensitivity function of the bat *Glossophaga soricina* is shown below



(a) (20 Points) Overlay a sketch an approximate spectral sensitivity function for a human on the figure and **compute** the range of photon energies in eV for humans. Be sure you clearly define what wavelengths you are using to define the limits of the visible spectrum since there are reasonable variations between our text and other WEB and print resources. You may already have the answers from Problem Set 1 which you may use.

(b) (15 Points) Compared to a human, the *Glossophaga soricina* bat, can "see" much, much better in the (**UV, Green-Yellow, Red, IR**) with a peak sensitivity in the (**UV, Green-Yellow, Red, IR**) and has virtually no vision acuity in the (**UV, Green-Yellow, Red, IR**). Circle your choices.