**Worksheet 2 (due at beginning of class 9/12/2557)**

1.     What is the value of band gap of diamond? Is it a semiconductor or an insulator? How does it compare with Si or Ge which are also group IV? (Hint: does that relate to lattice constant or bonding energy?) Can diamond be doped? (hint: feel free to look up in internet for ideas for an answer, you may quote or attach the references you used if necessary.)

2.     Comparing energy, wavelength and momentum

2.1.      In fiber optic communication, we use infrared light at 1300 nm and 1550 nm which have minimal optical absorption and pulse dispersion in the fiber glass material that the scientists had developed so far. What are the energies of photon at these wavelengths (in eV)? What semiconductor materials have similar value of band gap? Should we use direct or indirect band gap material as the light source? Bonus point if you can figure out the trick people engineer materials to obtain specific wavelength!

2.2.     What is the wavelength of the electron beam that is (a) in an SEM (scanning electron microscope) driven under 20 kV voltage (b) driven under 400 kV in a TEM (tunneling electron microscope). Comment on the image resolution from the two beam in comparison with each other. How about kinetic energy per electron in these beams (in unit of eV)?

3.    Write an expression for the Bohr radius of electron in a hydrogen atom. Justify this expression (You also derive it). Use an effective medium picture (screening effect due to the high permittivity (dielectric constant $ϵ\_{r}$) of the crystal lattice and effective mass of electron in the band) to find the Bohr radius of an electron due to a donor dopant in GaAs. How does this Bohr radius compare to the lattice constant of GaAs? Comment about whether this electron should be bound to the donor atom or become ionized in GaAs at room temperature?

 สามารถปรึกษาและทำร่วมกันกับเพื่อนได้ แต่การเขียนคำตอบต้องเรียบเรียงด้วยสำนวนภาษาของตนเอง (ไม่อนุญาตให้ลอก)