PHYSICS 4E QUIZ 3 (open book) SPRING QUARTER 2016
PROF. HIRSCH MAY 9

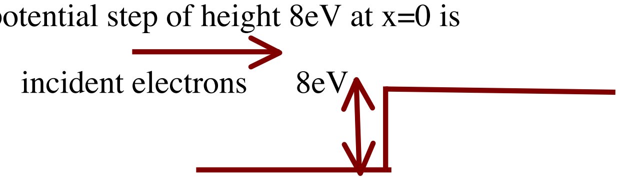
Show all steps in your calculations. Justify all answers. Write clearly.

Constants:
$$hc = 12{,}400 eVA,\ \ k_B = 1/11{,}600 eV/K,\ \ m_e c^2 = 511{,}000 eV$$
$$e^2 = 14.4 eVA,\ \ \hbar c = 1973\ eVA,\ \ m_p c^2 = 938.28 MeV,\ \ \hbar^2/(2m_e) = 3.81 eVA^2$$

Problem 1 (10 pts)
A finite square well of width L=6A has three bound states for an electron.
(a) What is the smallest possible value for the height of this well, in eV?
(b) Approximately how many bound states would this well have for a proton?
(c) What would approximately be the energy of the third state for an electron in this well if the height of the well was 100 times larger than the value found in (a)?
<u>**Hint:**</u> for the even solutions, tan(ka)=α/k; for the odd solutions, -cot(ka)=α/k; a=L/2.

Problem 2 (10 pts+2 extra credit)
Use the integral table in Appendix B-1. Show all steps in the calculations.
For the wavefunction
$$\Psi(x) = Ae^{-\gamma x^2}$$
(a) Find A in terms of γ so that the wavefunction is normalized.
(b) Find the uncertainty in position, Δx, in terms of γ, by direct calculation.
(c) Find the uncertainty in momentum, Δp, in terms of γ, by direct calculation. Use that
$$p_{op} = \frac{\hbar}{i}\frac{\partial}{\partial x}$$
(d) Find ΔxΔp and discuss the result.

Problem 3 (10 pts)
The wavefunction for electrons incident on a potential step of height 8eV at x=0 is
$$\psi(x) = e^{ik_1x} + Be^{-ik_1x} \qquad x<0$$
$$\psi(x) = 1.5e^{ik_2x} \qquad x>0$$



(a) Find B.
(b) For every 1000 incident electrons, how many are transmitted?
(c) Find the kinetic energy of the incident, reflected and transmitted electrons, in eV.
Justify all your answers.