Name : _____

Roll Number: _____

Question 1

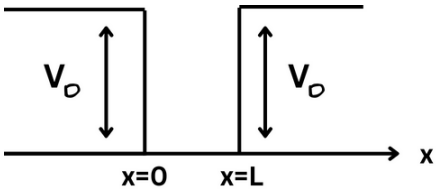
A hydrogen atom is in the state

$$\frac{1}{\sqrt{2}}(\psi_{100} - \psi_{200}).$$

Write the integral that, when computed, will give the probability of finding the electron between the radii $r = 0$ and $r = a_0$ (the Bohr radius). You do not have to compute this integral.

Question 2

An electron is in a finite potential well of height V_0 and length L (see figure).



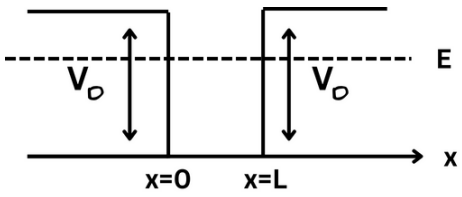
Use the uncertainty relation

$$\Delta x \Delta p \approx \hbar$$

to estimate the ground state energy for this system.

Question 3

An electron with energy, E, $60eV$ is trapped in a finite potential well. The height of the well, V_0, is $70eV$ (see figure).



(a) In which regions (use inequalities in x) will the particle never be found classically?

(b) Find, in terms of the mass of the electron, the penetration length of the electron into these classically forbidden regions. This is the length needed for the wavefunction to shrink by a factor of e once it enters the classically forbidden region (i.e. for the wavefunction to go from the value right before entering the forbidden region, say $\psi(b)$, to $\frac{\psi(b)}{e}$).

Do not use a memorised expression for the penetration length. You must justify it. Without a calculator, you will probably not be able to arrive at the exact number. Just try to massage the final form into something neat.

Question 4

Consider the hydrogen atom's 2s orbital.

(a) What are n, l, and m_l for this orbital?

(b) If an electron occupies the 2s orbital, what is the probability of finding the particle between r=0 and r=a_o (Bohr radius)?

(c) Find the radius at which $r^2|\psi(r, \theta, \phi)|^2$ is maximum for this orbital.