

# PHYS2040 – Quantum Physics – 2012

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**Assignment 2:** marked out of 30 but worth 10% of the final mark

Due date: Thursday 24 May 2012, during the Lecture at 16.00

Only handwritten notes are accepted (except for the computer program)!!!

## 1. Question (15 marks)

### The Finite Quantum Well

- (a) Derive the expression of the wave function for an electron inside and outside the finite quantum well.
- (b) Consider the case  $E > V_0$ . What do the wave-function solutions look like?
- (c) Calculate the energy levels of the finite quantum well with your computer by using 'matlab' or a similar program.

## Question 2 (15 marks):

### The Infinite Quantum Well

A particle in an infinite square well with the width  $L$  has an eigenfunction of:

$$\varphi(x) = \sqrt{\frac{2}{L}} \sin\left(\frac{3\pi x}{L}\right)$$

within the square well ( $0 \leq x \leq L$ ) and zero otherwise.

- (i) Determine the expectation value of  $x$ .
- (ii) Calculate the probability of finding the particle within  $\pm L/100$  around the center of the square well.
- (iii) Verify that the Heisenberg Uncertainty Principle is valid for this eigenstate by using  $\Delta x = \sqrt{\overline{x^2} - \bar{x}^2}$  and  $\Delta p = \sqrt{\overline{p^2} - \bar{p}^2}$ .
- (iv) Calculate the corresponding energy for this wavefunction.