

Quiz 3b: Modern Physics

Date: 12 April 2018

Useful Formulae

$$h = 6.63 \times 10^{-34} \text{ Js} \qquad m_e = 9.11 \times 10^{-31} \text{ kg}$$
$$E_n = \frac{-13.6}{n^2} \text{ eV in a } H \text{ atom} \qquad 1 \text{ eV} = 1.6 \times 10^{-19} \text{ J.}$$

1. What is the maximum and minimum wavelength emitted from a Hydrogen atom.

(5 marks)

2. The energy of an electron in the ground state is

$$E_1 = \frac{e^2}{4\pi\epsilon_0(2a_0)},$$

where $a_0 =$ Bohr's radius. Show that in the ground state of the bound H atom, the maximum distance of the electron from the nucleus can be $2a_0$. (5 marks)

3. A particle in one dimension is described by the normalized wavefunction

$$\psi(x) = \begin{cases} 0, & x < 0 \\ Ce^{-x}(1 - e^{-x}), & x \geq 0. \end{cases}$$

(a) Find C .

(b) An experiment is performed with a microscope aimed at locating the particle somewhere. At what location is it most likely to be found? (5 marks)

4. Consider the potential well shown below. Assume $E > V_0$. Sketch an approximate wavefunction for the eighth excited level. It has 8 nodes excluding the nodes at the walls. (5 marks)