Support Worksheet – Topic 6, Worksheet 4

1 **a** State the Heisenberg uncertainty principle for energy and time. [1]

b Determine the uncertainty in the energy of a quantum state in which the electron is expected to stay for no more than 10^{-8} s. [2]

2 **a** The Schrödinger theory uses wavefunctions. State what is meant by a **wavefunction**. [1]

b Suggest how energy levels come about in the Schrödinger theory. [1]

3 State two similarities and two differences between the Bohr and the Schrödinger theories. [4]

4 **a** The energy levels of atomic hydrogen according to the Bohr model are given by $E = -\frac{13.6}{n^2}$ eV. Determine the wavelength of the photon emitted in a transition from $n = 4$ to $n = 2$. [3]

b State the part of the electromagnetic spectrum that this photon belongs to. [1]

5 **a** An alpha particle of kinetic energy 4.8 MeV is projected head on towards a nucleus of an isotope of atomic number 28. Determine the distance of closest approach of the alpha particle to the nucleus. [3]

b Explain how closest distance experiments allow determination of nuclear radii. [3]

6 **a** State one way in which electron energies in beta decay differ from alpha particle energies in alpha decay and gamma ray energies in gamma decay. [1]

b Outline how your answer to **a** is evidence for nuclear energy levels. [2]

7 State one difference between atomic energy levels and nuclear energy levels. [1]

8 In alpha decay a photon is usually emitted in addition to the alpha particle. Suggest an explanation of this observation. [1]

9 The energy of an electron emitted in beta decay varies from zero up to a maximum value. Explain how this observation led to the discovery of the neutrino. [3]

10 **a** State what is meant by the **decay constant**. [1]

b The decay constant of a sample of a radioactive isotope is λ. At a particular instant, N nuclei of the radioactive isotope are present. State the activity of the sample at that instant. [1]

11 Show that the decay constant and the half-life of a radioactive isotope are related by $\lambda T_{1/2} = \ln 2$. [2]