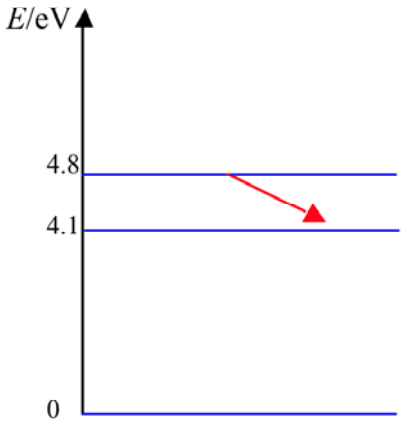
Extension Worksheet – Topic 6, Worksheet 1

1 Describe the distribution of mass and electric charge in an atom. [3]

2 The diagram shows the energy levels of a hypothetical atom.



An electron makes the indicated transition. Calculate the frequency and the wavelength of the emitted photon. [2]

3 State three ways in which the nuclei $^{12}_{6}\mathrm{C}$ and $^{14}_{6}\mathrm{C}$ differ. [3]

4 One of the dominant forces acting within the nucleus is the electrostatic force. State the name(s) of the particle(s) in the nucleus this force acts on. [1]

5 Another dominant force acting within the nucleus is the strong nuclear force. State the name(s) of the particle(s) in the nucleus this force acts on. [1]

6 **a** Large stable nuclei tend to have more neutrons than protons. Suggest why this is so. [3]

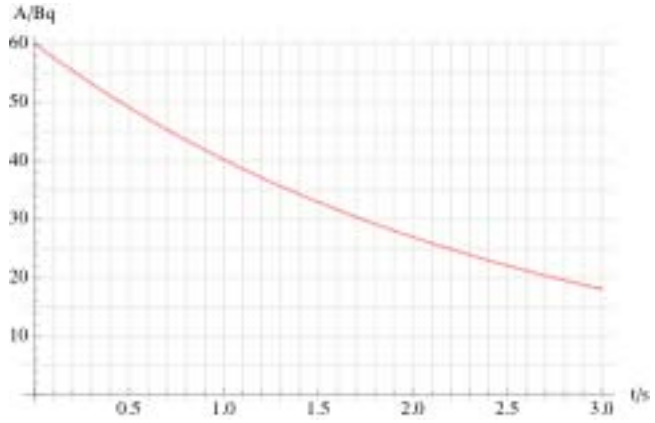
b On the other hand, if a nucleus has too many neutrons it will be unstable. Suggest the likely decay mode for such nuclei. [1]

7 **a** Describe how the emission spectrum of a gas may be obtained in a lab. [3]

b Suggest why the wavelengths of dark lines in the absorption spectrum of a gas are the same as the bright lines in the emission spectrum of the gas. [3]

8 A pure radioactive isotope has mass m and half-life T. The initial activity is A. State the half-life and initial activity of a pure sample of an identical isotope of mass $2m$. [2]

9 The graph shows how the activity (in Bq) of a radioactive sample varies with time (in s).

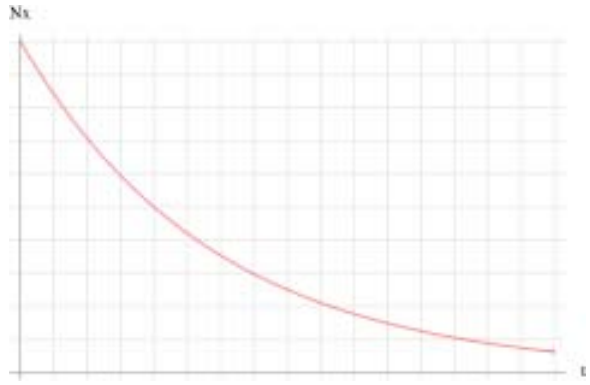


a Estimate the half-life of this isotope. [1]

b Estimate the number of nuclei that decayed in the first one second. [2]

c The energy released in one decay is 0.30 MeV. Estimate the average power generated in the first one second. [2]

10 An unstable radioactive isotope X decays into a stable isotope Y. Initially no nuclei of isotope Y are present. The graph shows how the number of X nuclei remaining in a sample varies with time.



On the same axes draw a sketch graph to show how the number of Y nuclei in the sample varies with time. [2]

11 In an experiment to measure the half-life of an isotope, a group of students measured the activity every 30 s for an interval of 5 minutes. The measurement of the initial activity was misplaced and was not available to the group. Can the students still determine the half-life? [2]

12 The half-life of a radioactive isotope is 5.0 minutes. After 5.0 minutes a particular nucleus has not decayed. State the probability that in the next 5.0 minutes this nucleus will in fact decay. [1]

13 Calculate the binding energy per nucleon of the nucleus of ${}^{4}_{2}\mathrm{He}$. (Mass of nucleus 4.00153 u.) [3]

14 Calculate the energy released in the fusion reaction ${}^{2}_{1}\mathrm{H} + {}^{2}_{1}\mathrm{H} \rightarrow {}^{3}_{2}\mathrm{He} + {}^{1}_{0}\mathrm{n}$. (Mass of ${}^{2}_{1}\mathrm{H}$ = 2.014 102 u, mass of ${}^{3}_{2}\mathrm{He}$ = 3.016 049 u.) [2]