Mark scheme for Extension Worksheet – Topic 6, Worksheet 1

1 Most of the mass of the atom is in the tiny nucleus; the positive charge of the atom is on protons inside the nucleus; the negative charge of the atom is on electrons that move around the nucleus. [3]

2 The energy emitted is 0.70 eV and so

$hf = E \Rightarrow f = \frac{0.70 \times 1.6 \times 10^{-19}}{6.63 \times 10^{-34}} = 1.689 \times 10^{14} \approx 1.7 \times 10^{14}$ Hz ;

$\lambda = \frac{c}{f} = \frac{3 \times 10^{8}}{1.689 \times 10^{14}} = 1.8 \times 10^{-6}$ m [2]

3 Compared to ${}^{12}_{6}C$, the nucleus of ${}^{14}_{6}C$ has more neutrons; bigger mass; and bigger radius. [3]

4 Protons. [1]

5 Protons and neutrons. [1]

6 **a** A large nucleus has many protons which tend to make the nucleus unstable because of the repulsive force between the protons; the protons exert electric repulsive forces on each other no matter what their separation; hence more neutrons are needed to contribute to binding. [3]

b They will decay by beta minus decay. [1]

7 **a** The gas that is kept at low pressure; is excited by exposing the gas to a high electric field; the emitted light is then allowed to pass through a diffraction grating/prism. [3]

b The dark lines correspond to photons that have been absorbed by electrons which then made a transition to a higher energy level; the difference in energy between the levels is the same as the energy of the photon absorbed; and so is the same as that emitted. [3]

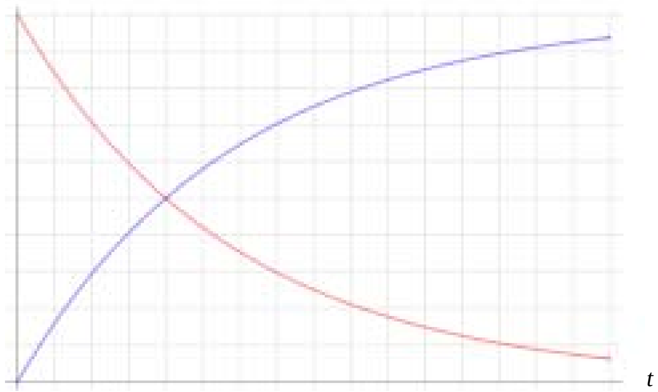
8 The half-life will remain the same; but the initial activity will double to 2*A*. [2]

9 **a** The activity becomes half the initial activity at 1.7 s so 1.7 s is the half-life. [1]

b The number of nuclei that decayed is the area under the curve; and this approximately $\frac{60+40}{2} \times 1.0 = 50$ [2]

c The energy released in 1 s is $0.30 \times 50 = 15$ MeV $= 15 \times 10^{6} \times 1.6 \times 10^{-19}$ $= 2.4 \times 10^{-12}$ J ; and so the average power is then 2.4×10^{-12} W [2]

10 See graph in blue (starting at the origin) for intersection point at correct time; and for correct values after two half-lives;



[2]

11 Yes they can; any other measurement of activity may be considered the initial value. [2]

12 The probability of a decay within an interval equal to a half-life is always 0.5. [1]

13 The mass defect is $2\times 1.007276 + 2\times 1.008665 - 4.00153 = 0.030352\text{ u}$; the binding energy is then $931.5\times 0.030352 = 28.27\text{ MeV}$; and so the binding energy per nucleon is $\frac{28.27}{4} = 7.1\text{ MeV}$ [3]

14 The mass difference is $2\times 2.014\ 102 - (3.016\ 049 + 1.008665) = 0.0349\text{ u}$; so the energy released is $931.5\times 0.0349 = 3.25\text{ MeV}$ [2]

