

- 7 A nucleus of bismuth-212 ( $^{212}_{83}\text{Bi}$ ) decays by the emission of an  $\alpha$ -particle and  $\gamma$ -radiation.

(a) State the number of protons and the number of neutrons in the nucleus of bismuth-212.

number of protons = .....

number of neutrons = .....

[1]

(b) The  $\gamma$ -radiation emitted from the nucleus has a wavelength of 3.8 pm.

Calculate the frequency of this radiation.

frequency = ..... Hz [3]

(c) Explain how a single beam of  $\alpha$ -particles and  $\gamma$ -radiation may be separated into a beam of  $\alpha$ -particles and a beam of  $\gamma$ -radiation.

.....  
 .....  
 .....  
 ..... [2]

(d) The  $\alpha$ -particle emitted from the bismuth nucleus has an initial kinetic energy of  $9.3 \times 10^{-13}$  J. As the  $\alpha$ -particle moves through air it causes the removal of electrons from atoms. The  $\alpha$ -particle loses energy and is stopped after removing  $1.8 \times 10^5$  electrons as it moved through the air.

Determine the energy, in eV, needed to remove one electron.

energy = ..... eV [2]

[Total: 8]

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