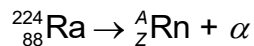


- 6** The isotope Radium-224 undergoes spontaneous decay and as a result, ionising radiation is produced. A stationary Radium- 224 nucleus decays to a Radon (Rn) nucleus by emitting an  $\alpha$ -particle with no gamma emission as shown in the equation below. The daughter nucleus is an isotope of Radon (Rn).



- (a)** A deuterium nucleus has half the mass number and charge of the  $\alpha$ -particle. Explain why a helium nucleus is more likely to be produced in the decay rather than two deuterium nuclei.

.....  
..... [1]

- (b)** Determine the number of neutrons and protons in a nucleus of Rn.

Number of neutrons = .....

Number of protons = ..... [1]

- (c)** The mass of the Radium nucleus is greater than the combined mass of the nuclei of Radon and the  $\alpha$ -particle. Use a conservation law to explain how this decay is possible.

.....  
..... [1]

**(d)** The kinetic energy of the Rn nucleus is 0.1037 MeV. Determine the energy of the  $\alpha$ -particle given the following information:

rest mass of  $^{224}_{88}\text{Ra}$  = 224.0202 u

rest mass of Rn = 220.0114 u

rest mass of  $\alpha$ -particle = 4.0026 u

Energy of  $\alpha$ -particle = ..... MeV [4]

**(e)** As the  $\alpha$ -particle travels in air, ionisation of air occurs. A neutral molecule becomes an ion-electron pair. The energy required to produce an ion-electron pair from a neutral molecule at atmospheric pressure is 31 eV.

By estimating the range of an  $\alpha$ -particle in air, calculate to two significant figures, the number of ion-electron pairs produced per unit length as the  $\alpha$ -particle is stopped in air at atmospheric pressure.

Number of ion-electron pairs produced per unit length = .....  $\text{m}^{-1}$  [3]