

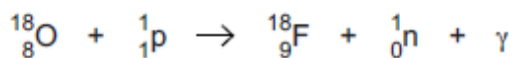
A Level Physics A

H556/02 Exploring physics

Question Set 22

1(a)

The nuclear reaction below shows how the isotope of fluorine-18 ($^{18}_9\text{F}$) is made from the isotope of oxygen-18 ($^{18}_8\text{O}$).



The oxygen-18 nucleus is **stationary** and the proton has kinetic energy of 0.25×10^{-11} J. The binding energy of the $^{18}_8\text{O}$ nucleus is 2.24×10^{-11} J and the binding energy of the $^{18}_9\text{F}$ nucleus is 2.20×10^{-11} J. The proton and the neutron have zero binding energy.

- (i) Explain why a high-speed proton is necessary to trigger the nuclear reaction shown above.

The proton is repelled by the nucleus, but a high speed one can get close. [2]

(ii)

- (ii) Estimate the minimum wavelength λ of the gamma ray photon (γ).

$$\begin{aligned} \text{Energy on RHS} &= \text{KE on LHS} - \text{loss in binding } E \\ &= 0.25 \times 10^{-11} - 0.04 \times 10^{-11} = 0.21 \times 10^{-11} \text{ J} \end{aligned}$$

$$E = \frac{hc}{\lambda} \text{ so } \lambda = \frac{hc}{E} = \frac{6.63 \times 10^{-34} \times 3 \times 10^8}{0.21 \times 10^{-11}} = 9.5 \times 10^{-14}$$

$$\lambda = \dots\dots\dots 9.5 \times 10^{-14} \text{ m} \quad [3]$$

- (iii) Fluorine-18 is a positron emitter.

Name a medical imaging technique that uses fluorine-18 and state one benefit of the technique.

- PET scans which are non-invasive. [2]

- (b) Describe how the components of a computerised axial tomography (CAT) scanner can produce high-quality images of the internal structures of a patient.

- The x-ray moves around the patient, firing a thin beam of radiation [4]
- This allows several cross sections to be constructed, and hence a 3D image

Total Marks for Question Set 22: 11

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