OCR
Oxford Cambridge and RSA

A Level Physics A

H556/02 Exploring physics

Question Set 22

1(a)

The nuclear reaction below shows how the isotope of fluorine-18 ($^{18}_{9}F$) is made from the isotope of oxygen-18 ($^{18}_{8}O$).

$$^{18}_{8}O + {}^{1}_{1}p \rightarrow {}^{18}_{9}F + {}^{1}_{0}n + \gamma$$

The oxygen-18 nucleus is **stationary** and the proton has kinetic energy of 0.25×10^{-11} J. The binding energy of the $^{18}_{8}O$ nucleus is 2.24×10^{-11} J and the binding energy of the $^{18}_{9}F$ 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).

Energy on RHS = KE on LHS − loss in binding E

$= 0.25\times10^{-11} - 0.04\times10^{-11} = 0.21\times10^{-11}$ J

$E = \frac{hc}{\lambda}$ so $\lambda = \frac{hc}{E} = \frac{6.63\times10^{-34}\times3\times10^{8}}{0.21\times10^{-11}} = 9.5\times10^{-14}$

$\lambda =$ 9.5×10^{-14} m **[3]**

(iii) Fluorine-18 is a positron emitter.

Name a medical imaging technique that uses fluorine-18 and state one benefit of the technique. **[2]**

- PET scans which are non-invasive.

(b) Describe how the components of a computerised axial tomography (CAT) scanner can produce high-quality images of the internal structures of a patient. **[4]**

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

Total Marks for Question Set 22: 11