

A Level Physics A

H556/02 Exploring physics

Question Set 12

1 Fluorine-18 is a common radioactive isotope used in positron emission tomography (PET). Fluorine-18 emits positrons. A patient is injected with a radiopharmaceutical containing fluorine-18.

(a) Describe how a PET scanner is used to locate an area of increased activity within the patient. [4]

Increased activity where the F-18 accumulates. Positrons from the F-18 annihilate electrons in the patient. This releases a pair of gamma photons travelling in opposite directions. Diametrically opposite detectors record the arrival times to pinpoint the location of increased activity.

(b) The half-life of fluorine-18 is 110 minutes. Calculate the time t in minutes for the activity of the radiopharmaceutical to decrease to 30% of its initial activity.

$$\lambda = \frac{\ln(2)}{T_{1/2}} = 6.3 \times 10^{-3} \text{ min}^{-1}$$

$$A = A_0 e^{-\lambda t} \quad \text{and} \quad \frac{A}{A_0} = 0.3 \Rightarrow 0.3 = e^{-6.3 \times 10^{-3} t}$$

$$t = \frac{\ln(0.3)}{-6.3 \times 10^{-3}} = 191 \text{ minutes}$$

$$t = \dots\dots\dots 190 (2sf) \dots\dots\dots \text{minutes} [3]$$

(c) PET scanners are not available in all hospitals. This is because fluorine-18 requires expensive on-site particle accelerators and fluorine-18 has a very small 'shelf-life'. Suggest the impact this may have on the treatment and diagnosis of patients in the country. [1]

- Some patients might not get treatment because of where they live.

Total Marks for Question Set 12: 8

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