24. Medical Physics

24.3 PET scanning

Paper 4

Marking Scheme

Q1.

(a)(i)	positron	**B1**
(b)(i)	• (pair) annihilation occurs • the mass of the two particles is converted into energy • two gamma photons are formed and travel in opposite directions **or** two gamma photons are formed and leave the body • difference in arrival times of photons (at detector) is processed *Any three points, 1 mark each*	**B3**
(b)(ii)	with a shorter half-life: sample would (almost) fully decay before the test is complete	**B1**
	a longer half-life: exposes patient to harmful/ionising radiation unnecessarily **or** with a longer half-life: a larger dose (of tracer) needed to produce detectable activity	**B1**

Q2.

(a)(i)	material introduced into the body **and** (position in body) can be detected **or** absorbed by the tissue (being studied)	**B1**
(b)(i)	positrons (emitted in the decay) and electrons annihilate	**B1**
	mass of particles becomes energy of gamma photons	**B1**
(b)(ii)	arrival times of photons are processed	**B1**
	image built up of tracer concentration in the tissue	**B1**

Q3.

(c)(i)	• electron and positron interact • positron is anti-particle of electron • (pair) annihilation occurs *Any two points, 1 mark each*	**B2**
	mass of the electron and positron converted into photon energy	**B1**
(c)(ii)	PET scanning	**B1**

Q4.

(a)(i)	introduction of tracer (into the body)	**M1**
	containing a β^+ emitter	**A1**
(a)(ii)	positron interacts with electron	**B1**
	(pair) annihilation occurs	**B1**
	mass of particles converted into gamma photons	**B1**
(b)	(annihilation of electron and positron) produces two photons	**B1**
	$E = (\Delta)mc^2$	**B1**
	$E = hf$ **and** $f = c / \lambda$ **or** $E = hc / \lambda$	**B1**
	$\lambda = \{[2\times]\ 6.63 \times 10^{-34} \times 3.00 \times 10^8\} / \{[2\times]\ 9.11 \times 10^{-31} \times (3.00 \times 10^8)^2\}$ $= 2.4(3) \times 10^{-12}$ m or 2.4(3) pm (*full substitution and answer with unit needed*)	**B1**

Q5.

(b)	total momentum (before and after interaction) is zero **or** momentum must be conserved (in the interaction) **or** momentum of the photons must be equal and opposite	**B1**
	(photons emitted in) opposite directions	**B1**