Mark schemes

Q1.

(a) the time taken to halve the amount of fluorine-18/ number of particles is 6 hours ✓[1]

✓[1] Condone 'mass' as alternative to 'amount'. Condone 'activity'

by excretion of fluorine-18 from the body (by biological means)✓[2]

✓[2] must include the idea that the fluorine is removed from the body

Do not allow decay in MP1 or in MP2

2

(b) Max 2 from ✓✓

Correct use of $\left(\frac{1}{T_E}\right) = \frac{1}{T_P} + \frac{1}{T_B}$ to find T_E ✓[a]

Use of their $T_E = \frac{ln2}{\lambda}$ to find their λ✓[b]

Use of $N = N_0 e^{-their\ \lambda \times t}$ to find their % remaining with consistent units ✓[c]

14 (%) ✓

✓[a] Expect:

$\frac{1}{T_E} = \frac{1}{110} + \frac{1}{6 \times 60}$ *∴ T_E = 84 mins (1.4 hours, 5055 s)*

✓[b] $\lambda = \frac{\ln 2}{84} = 8.3 \times 10^{-3}\ \text{mins}^{-1}$ *(0.50 hours^{-1}, 1.4 × $10^{-4}\ s^{-1}$)*

✓b Condone use of T_B or T_P

✓[c] $\frac{N}{N_0} = e^{-\lambda t} = e^{-8.3 \times 10^{-3} \times 4.0 \times 60} = 0.14$

Or

$N = N_0 e^{-\lambda t} = 100 e^{-8.3 \times 10^{-3} \times 4.0 \times 60} = 14\%$

Calculator value = 13.88419224

Alternative Method

Calculation of effective half-life ✓[a]

Uses their T_E to find number of half-lives in 4.0 hours with consistent units (e.g. 4.0/ 1.4 = 2.85) ✓[b]

✓b Condone use of T_B or T_P

Calculation of percentage remaining

$\frac{1}{2^{their\ number\ of\ half-lives}} \times 100$

OR $0.5^{their\ number\ of\ half\ -lives}$ × 100✓c

3

(c) Beta plus/positron and (electron) neutrino ✓

Ignore (incorrect) symbols.
Reference to emission of anti-neutrino, gamma, protons, neutrons or daughter nucleus scores zero.

1

(d) Use of 3×10^8 m s^{-1} (as speed of photons) ✓$_1$

Use of Pythagoras to determine AB or half AB OR appropriate use of scale ✓$_2$

Extra distance to travel to B = $(3 \times 10^8 \times 0.79 \times 10^{-9}) = 23.7 \times 10^{-2}$ (m)

OR calculates time for light to travel from A to B (2.36 ns) ✓$_3$

H5 from some correct working ✓$_4$

✓$_2$ *Ignore POT.*

✓$_2$ AB = $\sqrt{10^2 + 70^2}$ (= 70.7 cm) *Allow calculation in cm or number of squares (AB = 14.1 squares)*

✓$_2$ *Appropriate use of scale e.g. 23.7÷ 5 = 4.7 squares*

✓$_3$ *Allow use of half the time to work out distance from centre*

✓$_4$ *Allow credit for any method which uniquely identifies square H5 (Any grid reference takes precedence.)*

If no use of 3×10^8 m s^{-1} then a mark can be awarded for any square along the line AB that is closer to A (H1 - H7)

4

[10]

Q2.

Beta is more ionising/less penetrating than gamma 1✓

One from✓

- will produce localised ionisation of the tumour without reaching neighbouring healthy tissue (whereas the gamma will produce more extended ionisation)
- lower activity source can be used as more ionisation of the tumour per emission (whereas a more active gamma source will be required to produce the same level of ionisation in the tumour)
- the tumour is small so the ionisation will occur only in the tumour
- will cause less damage to healthy tissue (due to low penetration of beta)
- Will be more effective (at treating the tumour as) it will ionise/damage it to a greater extent than gamma

For two marks there must be a comparison implied and MP1 and MP2 must correlate

For two marks mention of ionisation must be seen

Accept 'damage' for 'ionise' in MP2 provided 'ionise' seen in MP1

For MP2 Condone: gamma could escape the body and pose a risk to others (beta cannot)

[2]