


Mark scheme – Uses and Hazards (H)

Question			Answer/Indicative content	Marks	Guidance
1			B ✓	1 (AO 1.1)	<p>Examiner's Comments</p> <p>This question required candidates to apply their scientific knowledge and analyse the information in the table about nuclear radiation in order to choose the best isotope to use as medical tracer.</p> <p> Misconception</p> <p>Many candidates could identify that gamma was the best radiation to use but had the misconception that a half-life of 6 minutes was long enough. Therefore, they incorrectly chose option C.</p> <p>Teaching often emphasises the need for a short half-life to reduce patient exposure to radiation, but this time cannot be shorter than the time required to carry out the procedure.</p>
			Total	1	
2			There is no (known) risk associated with ultrasound / ultrasounds are safer than X-rays / X-rays pass through soft tissue (so would not detect the kidney) / X-rays are ionising (radiation) ✓	1 (AO1.1)	<p>ALLOW X-rays used to detect bones/pass through kidney</p> <p>ALLOW ultrasound detects soft tissue/organs</p>
			Total	1	
3	a		Beta and gamma would not be absorbed/stopped (by smoke) ✓	1 (AO1.1)	ALLOW beta and gamma would pass straight through / are too penetrating / penetrate further / less ionising
	b		<p>Any two from:</p> <p>(Agree)</p> <p>Smoke alarms use small amounts of americium-241 ✓</p> <p>Mainly emits alpha particles which are stopped by skin/soil ✓</p> <p>Americium-241 is contained within the foil / AW ✓</p> <p>Americium-241 cannot move out of materials in detector / be inhaled ✓</p>	2 (AO2 × 3.2a)	IGNORE vague answers such as 'bad for the environment'

			Soil emits more radiation ✓ Or Any two from: (Disagree) Smoke alarm contains an isotope with a long half-life ✓ The smoke alarm/foil could be damaged ✓ Americium-241 may contaminate objects (in the waste) ✓ Americium-241 also emits gamma rays (which are more penetrating than alpha particles) ✓ Soil may not absorb all radiation ✓		ALLOW gamma is not stopped by the foil
	c	i	The time it takes the number of (undecayed/radioactive) nuclei to halve ✓	2 (AO1.1)	ALLOW count-rate or activity for number of undecayed nuclei ALLOW the time it takes for half of the (radioactive) nuclei to decay ALLOW atoms for nuclei
		ii	It is long enough so the activity does not change significantly / source will not need to be replaced ✓	1 (AO2.1)	ALLOW it will last a long time
		iii	Thorium (is greatest risk to begin with) / ORA ✓ As thorium will have a higher activity/count-rate (at the beginning) / ORA ✓	2 (AO2 × 3.2a)	ALLOW thorium decays faster / ORA
			Total	7	
4	a		Decreases ✓ Stays the same ✓	2 (AO2 × 2.1)	
	b	i	(Partial) reflection/absorption at the front of the kidney ✓ (Partial) reflection at the back of the kidney ✓	2 (AO2 × 2.1)	Both of the marking points can be awarded by a suitably clear diagram (or additional drawings on the given diagram) ALLOW 1 mark maximum for just reflection/bounces back
		ii	Measure the <u>time</u> between reflections ✓ Use distance = $\frac{1}{2}$ × speed × time (to find the size) ✓	2 (AO2 × 2.2)	ALLOW distance = speed × time and mention of time halve
			Total	6	
5	a	i	Any one from: Both produce energy ✓ Both convert mass to energy / have a "loss" in mass ✓ Both produce neutrons	1 (AO 1.1)	

		ii	<p>Any one from: In fusion nuclei join / in fission nuclei split/decay/break up / AW ✓</p> <p>fusion occurs at higher temperatures or pressures / fission occurs at lower temperatures or pressures ✓</p> <p>larger/heavier nucleus forms in fusion / smaller/lighter/daughter nuclei forms in fission ✓</p> <p>more energy released in fusion / less energy released in fission ✓</p> <p>fission causes a chain reaction / fusion does not cause a chain reaction ✓</p> <p>fusion does not produce (radioactive) waste / fission does produce radioactive waste ✓</p>	1 (AO 1.1)	<p>ALLOW atom IGNORE molecules / particles / ions</p> <p>ALLOW only fission reactors are used at present to produce electricity</p>
	b	i	Neutron(s) ✓	1 (AO 1.1)	<p>IGNORE gamma</p> <p>Examiner's Comments</p> <p>About two thirds of the candidates did not know that neutrons were also produced in a fusion reaction. Common misconceptions included water, carbon dioxide and protons.</p>
		ii	<p>Any one from: Gravity ✓</p> <p>(very) high temperatures ✓</p> <p>high pressure ✓</p>	1 (AO 1.1)	<p>ALLOW (high) gravitational field strength</p> <p>ALLOW hot (temperatures) / lots of heat IGNORE just heat</p> <p>Examiner's Comments</p> <p>The majority of candidates answered this correctly.</p>
			Total	4	
6	a		<p>Contamination occurs when radioactive source / material is on or in the body / object ✓</p> <p>Irradiation occurs when object is exposed to radiation (from outside of the body / object) ✓</p>	2 (AO1.1) (AO1.1)	<p>ALLOW material becomes radioactive / becomes a source of radiation</p> <p>Examiner's Comments</p> <p>Only a small number of candidates were unable to explain the difference between irradiation and contamination. A common misconception was candidates that confused the terms 'radiation' and 'radioactive source' in their explanation.</p>
	b		<p>Bacteria is killed / AW ✓</p> <p>Slows food decay / AW ✓</p>	2 (AO2.2) (AO2.2)	

					<p>ALLOW idea that food does not go mouldy / off / rot (so quickly)</p> <p>IGNORE just that food lasts longer / food does not go stale / food stays fresh</p> <p>Examiner's Comments</p> <p style="text-align: center;">?</p> <p>A complete explanation linking the bacteria being killed by gamma rays to the slowing down of the decay of the food was only given by higher ability candidates. Many candidates did not know that gamma rays kill bacteria. A common misconception was that gamma rays 'give energy to the food'.</p>
	c		<p>May cause food to become radioactive ✓</p> <p>May allow food (to be sold) which is old but looks fresh / AW ✓</p>	<p>2 (AO2.2)</p> <p>(AO2.2)</p>	<p>ALLOW food becomes contaminated / risk of cancer / they are taking in radiation</p> <p>ALLOW food might taste different / strange / out of date food might be eaten</p> <p>IGNORE food is poisonous / just unsafe</p> <p>Examiner's Comments</p> <p>The majority of candidates gained one mark for stating the concern that the food may become radioactive or cause cancer. It was rare for a second valid concern to be given by a candidate.</p>
			Total	6	