Nuclear Physics - MS

1.

nuclei decreases	do not accept atoms	1 1
m = 0.004 (kg) E = 0.004 × 5200 × 50 000 000 E = 1.04 × 10^9 (J) **or** E = 1 040 000 000 (J)	 allow a correct substitution of an incorrectly/not converted value of m allow a correct calculation using an incorrectly/not converted value of m	1 1 1
any **two** from: • to make sure the fusion process is possible • to develop an understanding of the process • to make adaptations to the process • to assess the efficiency of the process • to make predictions • assess safety risks • to assess environmental impact • set-up cost is lower (for small scale experiments)		2

releases carbon dioxide which causes global warming **OR** releases particulates which causes global dimming **or** which causes breathing problems **OR** releases sulfur dioxide which causes acid rain **OR** releases nitrogen oxides which causes breathing problems **or** which causes acid rain	allow releases greenhouse gases allow which causes climate change	1 1

2.

148		1
D and E		1
line between B and 86 protons same line between B and 222 mass number		1 1
can't predict which nucleus will decay next **or** can't predict when a (particular) nucleus will decay		1
one alpha decay would decrease proton number by 2 two beta decays would increase proton number by 2 so the proton / atomic number of the final nucleus is the same as the proton / atomic number of the original nucleus	this mark is dependent on scoring the first two marks	1 1 1

3.

Any **one** from: • (medical) x-rays • radiotherapy • nuclear weapons (testing) • named nuclear disaster eg Chernobyl / Fukushima / Three Mile Island.	allow CT scans allow nuclear fallout ignore radioactive / nuclear waste	1
uranium / plutonium	ignore any number given allow thorium	1
neutron absorbed by a uranium nucleus		1
nucleus splits into two parts	allow an atom splits into two parts if 1st marking point doesn't score	1
and (2 / 3) neutrons (are released)		1
and gamma rays (are emitted)		1
lighter nuclei join to form heavier nuclei	allow specific examples	1
some of the mass (of the nuclei) is converted to energy (of radiation)		1

4.

$^{206}_{82}Pb$		1 1
alpha radiation is highly ionising		1
causing an increased risk of cancer **or** organ failure **or** radiation sickness / poisoning **or** mutation of genes / DNA **or** damage to cells / tissues / organs	allow kill cells	1
until the radioactive material is removed / excreted **or** activity of radioactive material reaches / approaches background radiation levels	allow all the alpha radiation is absorbed by the body ignore references to half-life	1
$\frac{414}{138} = 3$ (half-lives)	an answer of 1.16×10^{-3} (g) scores **3** marks	1
$1.45 \times 10^{-4} \times 2 \times 2 \times 2$		1
$= 1.16 \times 10^{-3}$ (g) **or** = 0.00116 (g)		1

5.

	an answer of 13.95 (per second) scores **3** marks an answer of 13.95 (per second) scores **2** marks an answer of 801 (per second) scores **2** marks	
count rate = $\frac{819}{60}$		1
count rate = 13.65		1
corrected count rate = 13.35 (per second)		1
	allow an answer of background = 0.30 × 60 = 18 (per minute) corrected count rate = 819 – 18 corrected count rate = 801 per minute	
	an answer of 225 000 (Bq) scores **2** marks	
activity = 1250 × 180		1
activity = 225 000 (Bq)		1
yearly dose = 0.003 × 365	allow yearly dose = 1.095 (mSv)	1
which is << 100 (mSv) **or** (well) below the lowest dose with evidence of causing cancer / harm		1

6.

06.1	smoke absorbs / stops alpha radiation	allow alpha particles for alpha radiation alpha radiation does not reach the detector is insufficient	1
06.2	alpha radiation is not very penetrating **or** alpha radiation does not penetrate skin	allow alpha particles for alpha radiation allow alpha radiation does not travel very far (in air)	1
06.3	beta and gamma radiation will penetrate smoke no change (in the count rate) would be detected	allow beta and gamma radiation will not be stopped by smoke allow the change detected (in the count rate) would be too small	1 1
06.4	(a long half-life means) the count rate is (approximately) constant **or** a short half-life means the count rate decreases quickly until 1.3 half-lives the count rate is above 80 per second **or** until 1.3 half-lives the count rate is above the threshold for the smoke alarm to be activated **or** after 1.3 half-lives the smoke alarm will be activated all the time	allow activity of source is (approximately) constant allow after 1.3 half-lives the count rate is below 80 per second so don't have to replace source or smoke detector is insufficient	1 1

06.5	**Level 2:** Relevant points (reasons / causes) are identified, given in detail and logically linked to form a clear account.	3–4
	Level 1: Relevant points (reasons / causes) are identified, and there are attempts at logically linking. The resulting account is not fully clear.	1–2
	No relevant content	0
	Indicative content • short half-life or half-life of a few hours • (short half-life means) less damage to cells / tissues / organs / body • low ionising power • (low ionising power means) less damage to cells / tissues / organs / body • highly penetrating • (highly penetrating means) it can be detected outside the body • emits gamma radiation	

7.

cannot predict <u>which</u> dice / atom will 'decay' cannot predict <u>when</u> a dice / atom will 'decay'	accept answers given in terms of 'roll a 6'	1 1
3.6 to 3.7 (rolls)	allow **1** mark for attempt to read graph when number of dice = 50	2
90		1
uranium		1
beta proton number has gone up (as neutron decays to proton and e^-)		1 1
prevents contamination **or** prevents transfer of radioactive material to teacher's hands which would cause damage / irradiation over a longer time period.		1 1