Nuclear Radiation GCSE AQA Higher Physics Past Papers Answers

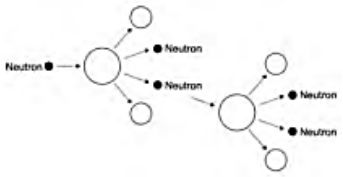
01.

Question	Answers	Extra information	Mark	AO / Spec. Ref.
1	negatively charged		1	AO1/1
	electrons are transferred		1	4.2.5.1
	from the (neutral) object		1	
2	minimum of four lines drawn perpendicular to surface of sphere	judge by eye	1	AO1/1 4.2.5.2
	minimum of one arrow shown pointing away from sphere	do **not** accept any arrow pointing inwards.	1	
3	Q		1	AO3/1a 4.2.5.2
Total			**6**	

02.

Question	Answers	Extra information	Mark	AO / Spec. Ref.
1	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	AO3/1b 4.4.2.3 WS1
2	3.6 to 3.7 (rolls)	allow **1** mark for attempt to read graph when number of dice = 50	2	AO2/2 4.4.2.3 WS3
3	90		1	AO2/1 4.4.2.2
4	uranium		1	AO2/1 4.4.1.2
5	beta proton number has gone up (as neutron decays to proton and e^-)		1 1	AO1/1 AO3/2a 4.4.2.2
6	prevents contamination **or** prevents transfer of radioactive material to teacher's hands which would cause damage / irradiation over a longer time period.		1 1	AO1/1 AO2/1 4.4.2.4
Total			**10**	

03.

Question	Answers	Extra information	Mark	AO / Spec. Ref.
1	Nucleus splitting into two fragments and releasing two or three neutrons (at least one) fission neutron shown to be absorbed by additional large nucleus and causing fission two or three additional neutrons released from fission reaction	This diagram would gain all **3** marks:  	1 1 1	AO1/1 4.4.4.1
2	lowering the control rods increases the number of neutrons absorbed (so) energy released decreases	accept converse description allow changing the position of the control rods affects the number of neutrons absorbed for **1** mark	1 1	AO2/2 AO1/1 4.4.4.1
3	rate of increase between 240 and 276 (MW / min)	allow **1** mark for attempt to calculate gradient of line at 10 minutes	2	AO2/1 4.4.4.1
Total			**7**	

04.

Question	Answers	Extra information	Mark	AO/ Spec. Ref
1		an answer of 13.35 (per second) scores **3** marks an answer of 13.95 (per second) scores **2** marks an answer of 801 (per second) scores **2** marks		AO2 4.4.2.1 4.4.3.1
	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		
2		an answer of 225 000 (Bq) scores **2** marks		AO2 4.4.2.1
	activity = 1250 × 180		1	
	activity = 225 000 (Bq)		1	
3	yearly dose = 0.003 × 365	allow yearly dose = 1.095 (mSv)	1	AO3 4.4.3.1
	which is << 100 (mSv) **or** (well) below the lowest dose with evidence of causing cancer / harm		1	
4	people are able to compare a radiation risk / dose / hazard to the radiation dose from (eating) bananas		1	AO3 4.4.2.4
Total			**8**	

05.

Question	Answers	Extra information	Mark	AO/ Spec. Ref
1	smoke absorbs / stops alpha radiation	allow alpha particles for alpha radiation alpha radiation does not reach the detector is insufficient	1	AO2 4.4.2.1
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	AO1 4.4.2.1
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	AO2 4.4.2.1
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	AO3 4.4.2.3

Question	Answers	Mark	AO/ Spec. Ref
5	**Level 2:** Relevant points (reasons / causes) are identified, given in detail and logically linked to form a clear account.	3–4	AO2 4.4.3.3
	Level 1: Relevant points (reasons / causes) are identified, and there are attempts at logically linking. The resulting account is not fully clear.	1–2	AO1 4.4.3.3
	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		
Total		**10**	

06.

Question	Answers	Extra information	Mark	AO/ Spec. Ref
1	any **three** from: • no carbon dioxide emitted (to produce electricity) • doesn't cause global warming • nuclear power doesn't cause earthquakes • more energy released per kg of fuel (compared to shale gas)	no greenhouse gases is insufficient allow climate change or greenhouse effect for global warming	3	AO1 AO2 4.1.3
2	uranium **or** plutonium	ignore any numbers given	1	AO1 4.4.4.1
3	a neutron is absorbed by a (large) nucleus the nucleus splits into two (smaller) nuclei releasing energy (and gamma rays) and (two / three) neutrons	a description in terms of only atoms negates first two marking points	1 1 1 1	AO1 4.4.4.1
Total			**8**	

07.

Question	Answers	Extra information	Mark	AO / Spec. Ref.
1	$^{206}_{82}Pb$		1 1	4.4.2.2 AO1
2	alpha radiation is highly ionising causing an increased risk of cancer **or** organ failure **or** radiation sickness / poisoning **or** mutation of genes / DNA **or** damage to cells / tissues / organs until the radioactive material is removed / excreted **or** activity of radioactive material reaches / approaches background radiation levels	 allow kill cells allow all the alpha radiation is absorbed by the body ignore references to half-life	1 1 1	4.4.2.4 AO1
3	$\frac{414}{138} = 3$ (half-lives) $1.45 \times 10^{-4} \times 2 \times 2 \times 2$ $= 1.16 \times 10^{-3}$ (g) **or** = 0.00116 (g)	an answer of 1.16×10^{-3} (g) scores **3** marks	1 1 1	4.4.2.3 AO2
Total			**8**	

08.

Question	Answers	Extra information	Mark	AO / Spec. Ref.
1	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	AO1 4.4.3.1
2	uranium / plutonium	ignore any number given allow thorium	1	AO1 4.4.4.1
3	neutron absorbed by a uranium nucleus nucleus splits into two parts and (2 / 3) neutrons (are released) and gamma rays (are emitted)	allow an atom splits into two parts if 1st marking point doesn't score	1 1 1 1	AO1 4.4.4.1
4	lighter nuclei join to form heavier nuclei some of the mass (of the nuclei) is converted to energy (of radiation)	allow specific examples	1 1	AO1 4.4.4.2
5	activity decreases quickly risk of harm decreases quickly	allow nuclei / waste will decay at a greater rate ignore waste is radioactive for less time allow burial site doesn't need to be monitored for as long **or** doesn't need to be buried underground for as long **or** may not need to be buried underground	1 1	AO3 4.4.2.3
Total			**10**	

09.

Question	Answers	Extra information	Mark	AO / Spec. Ref.
1	nuclei decreases	do not accept atoms	1 1	AO1 4.4.4.2
2	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	AO2 4.3.2.2 4.1.1.3
3	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	AO3 4.1.3

4	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	AO1 4.1.3
Total			**9**	

10.

Question	Answers	Extra information	Mark	AO / Spec. Ref.
1	148		1	AO1 4.4.1.2
2	D and E		1	AO1 4.4.1.2
3	line between B and 86 protons same line between B and 222 mass number		1 1	AO2 4.4.2.2
4	can't predict which nucleus will decay next **or** can't predict when a (particular) nucleus will decay		1	AO1 4.4.2.3
5	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	AO1 4.4.2.2
Total			**8**	

11.

Question	Answers	Extra information	Mark	AO / Spec. Ref.
1	two protons and two neutrons	allow helium nucleus ignore symbols	1	AO1 4.4.2.1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
2	85 37	this order only	1 1	AO1 4.4.2.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
3	alpha radiation has a low penetrating ability		1	AO1 4.4.2.4
	(so externally) alpha radiation is stopped by skin (so is low risk)	allow absorbed for stopped ignore reference to range of alpha particles through other materials	1	
	internally, alpha radiation is absorbed by living tissue / organs	allow (internal) contamination will increase the radiation dose	1	
	(as) alpha radiation is highly ionising		1	
	(internal) contamination will cause greater (risk of) harm to cells / tissues / organs / DNA / genes	allow contamination causes greater chance of developing cancer allow greater chance of mutations	1	

Total Question		**8**

12.

Question	Answers	Extra information	Mark	AO / Spec. Ref.
1	Similarities: • same number of protons **or** same atomic number	allow both atoms / nuclei contain 6 protons	1	AO1 4.4.1.1
	• same number of electrons		1	
	Difference: • different number of neutrons **or** different mass number	allow carbon-12 has 6 neutrons **and** carbon-14 has 8 neutrons	1	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
2	the time it takes for the number of nuclei (in a radioactive sample) to halve (is 5700 years) **or** the time it takes for the activity (of a radioactive sample) to halve (is 5700 years) **or** the time it takes for the radiation emitted (by a radioactive sample) to halve (is 5700 years) **or** the time it takes for the count rate (of a radioactive sample) to halve (is 5700 years) **or** the time it takes for the mass of carbon-14 (in a sample) to halve (is 5700 years)	allow atoms for nuclei ignore radioactivity	1	AO1 4.4.2.3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
3	2 half-lives		1	AO2 4.4.2.3
	128.74 (s)	allow 129 (s)	1	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
4	nitrogen-18		1	AO3 4.4.2.1
	greatest activity	MP2 and MP3 dependent on scoring MP1 allow emits most radiation per second allow emits most radiation in a given time period ignore shortest half-life	1	4.4.3.3
	(so) greatest dose of radiation absorbed (per second)		1	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
5	irradiation is the exposure of an object / person to radiation	allow 'absorption of radiation' for 'exposure' allow specific examples of ionising radiation	1	AO1 4.4.2.4
	(while) contamination is the (unwanted) presence of radioactive material / atoms on an object / person	allow 'inside a person' for 'on an object / person'	1	

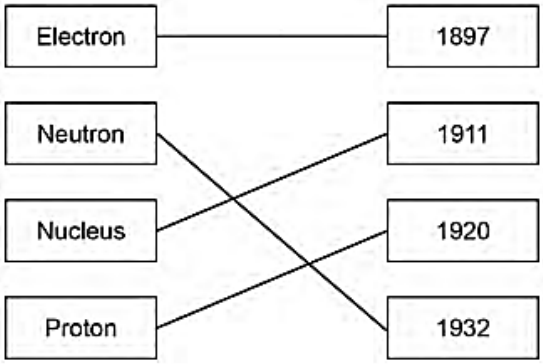
Question	Answers	Extra information	Mark	AO / Spec. Ref.
6	any **one** from: • cancer / tumours • DNA / genetic mutation • damages / kills cells • radiation poisoning / sickness / burns	ignore mutates cells ignore death	1	AO3 4.4.3.3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
7	some radioactive materials emit alpha radiation which has a (very) short range (in air)	 MP2 dependent on scoring MP1 allow weakly penetrating for short range (in air)	1 1	AO3 4.4.2.1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
8	pilot's dose in 24 hours = 0.072 (mSv) number of days = $\frac{0.072}{0.00050}$ number of days = 144 OR nuclear power worker hourly dose = 0.0000208… (mSv) (1) number of days = $\frac{0.0030}{0.0000208}$ (1) number of days = 144 (1) OR $\frac{\text{hourly dose}}{\text{daily dose}} = \frac{0.0030}{0.00050} = 6$ (1) number of days = 6 × 24 (1) number of days = 144 (1)		1 1 1	AO2 4.4.3.1

Total Question		17

13.

Question	Answers	Mark	AO / Spec. Ref.
1	Particle / Year of discovery  4 correct for 2 marks 2 or 3 correct for 1 mark additional line from a box on the left negates the mark for that box	2	AO1 4.4.1.3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
2		'it' is alpha particle **A**		AO1
	both the alpha particles and the (gold) nucleus have positive / same charge	allow alpha particles and protons have positive / same charge	1	
				AO3
	so the alpha particle and the gold nucleus repel each other	allow like charges repel ignore deflection (this refers to the path taken not the force)	1	4.4.1.1 4.2.5.1 4.2.5.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
3	particle **B** passes closer to the nucleus so experiences a stronger (repulsive) force **or** so experiences a stronger electric field	'it' is particle **B** any mention of particle **B** colliding with the nucleus scores zero	1 1	AO3 4.4.1.1 4.2.5.1 4.2.5.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
4	the atom is mostly empty space		1	AO3 4.4.1.3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
5	in the Bohr model the electrons orbit (the nucleus) at specific distances (whereas in the nuclear model the electrons can orbit at a continuous range of distances)	allow energy levels or shells for specific distances	1	AO1 4.4.1.3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
6	to move to a higher energy level an electron absorbs energy from electromagnetic radiation	allow absorbs energy by collision with another electron allow EM radiation for electromagnetic radiation	1	AO1 4.4.1.1
	to move to a lower energy level an electron emits energy in the form of electromagnetic radiation	if no other mark scored allow 1 mark for an electron changes energy level by emitting or absorbing electromagnetic radiation	1	

Total Question	**10**