AQA GCSE Combined Science - Trilogy | 8464

SPECIFICATION POINT 6.4.2.4

Radioactive contamination

Mark schemes and examiner comments

Tier	**Higher**
Question groups	**3**
Available paper years	**2018–2024**

Using this booklet

1. Booklet answer numbers match the question booklet.
2. Use the original question number within marking tables.
3. Examiner comments are included where available.

Name: _____ **Date:** _____

Where a precise marking extract is unavailable, the full source document is included in an appendix. Any missing mark scheme is explicitly identified.

6.4.2.4 Radioactive contamination

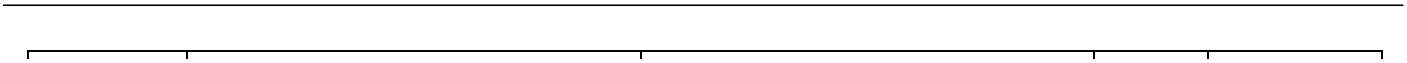
Answer 01 · Mark scheme June 2018 | 8464/P/1H | Original Q4

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.1	2 charged particles and 2 neutral particles		1	AO1 6.4.2.1
04.2	it is the type of radiation with a negative charge		1	AO1 6.4.2.1
04.3	it has a very long range in air		1	AO1 6.4.2.1
04.4	risk / activity associated with iodine-131 has decreased by a large amount		1	AO3 6.4.2.3
	because of short half-life	allow many half-lives have passed allow half-life is only 8 days 2nd marking point dependent on 1st marking point	1	
	risk / activity associated with caesium-137 will not have decreased by much	allow activity has halved	1	
	because of long half-life	allow only one half-life has passed 4th marking point dependent on 3rd marking point	1	
04.5		an answer of 2136 scores **3** marks		AO2 6.4.2.3
	5 half-lives	allow any correct method eg ½ × ½ × ½ × ½ × ½ = 1/32	1	
	5 × 30 = 150		1	
	1986 + 150 = 2136	any calculation using a value of 137 scores zero	1	
Total			**10**	

6.4.2.4 Radioactive contamination

Answer 01 · Mark scheme

June 2018 | 8464/P/1H | Original Q4



6.4.2.4 Radioactive contamination

Answer 02 · Mark scheme

June 2023 | 8464/P/1H | Original Q4

Question 4

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.1	peer review		1	AO1 6.4.2.4

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.2	it is ionising	ignore references to penetrating ability	1	AO1 6.4.2.4 6.4.2.1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.3	becquerel / Bq		1	AO1 6.4.2.1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.4	not all the radiation emitted (by the sample) is detected (because) the radiation spreads out **or** (because) some radiation is absorbed before reaching the detector **or** (because) some of the radiation entering the detector is **not** detected	 allow because the radiation is emitted in all directions	1 1	AO1 6.4.2.1

6.4.2.4 Radioactive contamination

Answer 02 · Mark scheme

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.5	alpha radiation because the radiation is not detected beyond 5 cm **or** because alpha radiation cannot travel 10 cm (in air) **or** because beta **and** gamma radiation would be detected at 10 cm	 dependent on MP1 allow because alpha radiation cannot travel more than a few cm (in air)	1 1	AO1 6.4.2.1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.6	60 minutes is 4 half-lives 30 minutes is 2 half-lives X = 392	allow 15 minutes is 1 half-life allow 1568 → 784 → 392 → 196 → 98 allow $\frac{1568}{98} = 2^4$ allow $\frac{98}{1568} = \frac{1}{2^4}$	1 1 1	AO3 6.4.2.3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.7	radioactive decay is a random process		1	AO1 6.4.2.3

Total Question 4	**11**

6.4.2.4 Radioactive contamination

Answer 03 · Mark scheme June 2024 | 8464/P/1H | Original Q5

Question 5

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.1		allow risk for hazard throughout		AO1 6.4.2.4
	Irradiating			
	EITHER			
	radiation enters the water	allow alpha / beta / gamma enters the water allow the water does not become radioactive	1	
	(which) does not affect the hazard	dependent on MP1	1	
	OR			
	because radiation can kill pathogens (1)	allow named pathogens e.g. bacteria, viruses		
	(irradiating) decreases the hazard (1)	dependent on MP1		
	contaminating			
	because radioactive isotopes will enter the water / body		1	
	(contaminating) increases the hazard	dependent on MP3	1	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.2	$^{52}_{23}V \rightarrow {}^{52}_{24}Cr + {}^{0}_{-1}\beta$		1	AO2 6.4.2.2

6.4.2.4 Radioactive contamination

Answer 03 · Mark scheme

June 2024 | 8464/P/1H | Original Q5

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.3	**radon-222** activity remained (almost) the same	allow the radiation emitted (each second) decreased by a small amount	1	AO3 6.4.2.3
	because 7.4 minutes is only a very small fraction of 3.8 days	allow 7.4 minutes is much smaller than 3.8 days allow the time is much less than the half-life	1	
	vanadium-52 activity decreased by a factor of 4		1	
	because 2 half-lives had passed		1	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.4	peer review		1	AO1 6.4.2.4

Total Question 5	10

6.4.2.4 Radioactive contamination

Answer 01 · Examiner comments June 2018 | 8464/P/1H | Original Q4

Question 4 (Standard/high demand)

04.1 51% of students knew what an alpha particle consists of.

04.2 70% of students knew that a particle of beta radiation has a negative charge.

04.3 63% of students knew that gamma radiation has a very long range in air.

04.4 45% of students scored marks on this question. Students who failed to score often understood there is a risk associated with nuclear radiation but were unable to relate that to the changing levels of radiation with time. There were lots of misconceptions about half-life, the most common being that iodine-131 would not emit any radiation after two half-lives.

6.4.2.4 Radioactive contamination

Answer 02 · Examiner comments June 2023 | 8464/P/1H | Original Q4

Question 04 (Standard, standard/high and high demand)

04.1 Only about a fifth of students correctly identified peer review as the process. It was common for students to suggest peer assessment, and some students wrote about double-blind trials.

04.2 About 35% of students answered this question correctly. Many students answered by giving a type of radiation (alpha, beta, or gamma) rather than stating a property.

04.3 Just under a quarter of students gave the correct unit. Phonetic spelling was acceptable, but if students abbreviated their answer to Bq, they had to use a capital B and a lower case q.

04.4 About 20% of students scored at least 1 mark on this question. Some suggested the idea of background radiation, which was not relevant to answering the question and is not mentioned on this specification. A number of students confused count-rate with half-life, and some students suggested that the radiation would be too fast for the detector to detect.

04.5 Approximately 55% of students identified that alpha radiation was emitted by the source, but only about a fifth of students could explain how the data showed this. Stating that alpha has a low range in air was too vague to gain the mark. Other answers which were insufficient for the second marking point included that it was alpha because as distance increases the count rate decreases.

04.6 Around a third of students gained all three marks on this calculation, with most other students scoring no marks. It was reasonably common for students to calculate 1568/98, and decide that 16 half-lives had passed, which scored no marks. Another common incorrect answer was to find the value halfway between 1568 and 98.

04.7 Just over 70% of students selected the correct answer, that radioactive decay is a random process.

6.4.2.4 Radioactive contamination

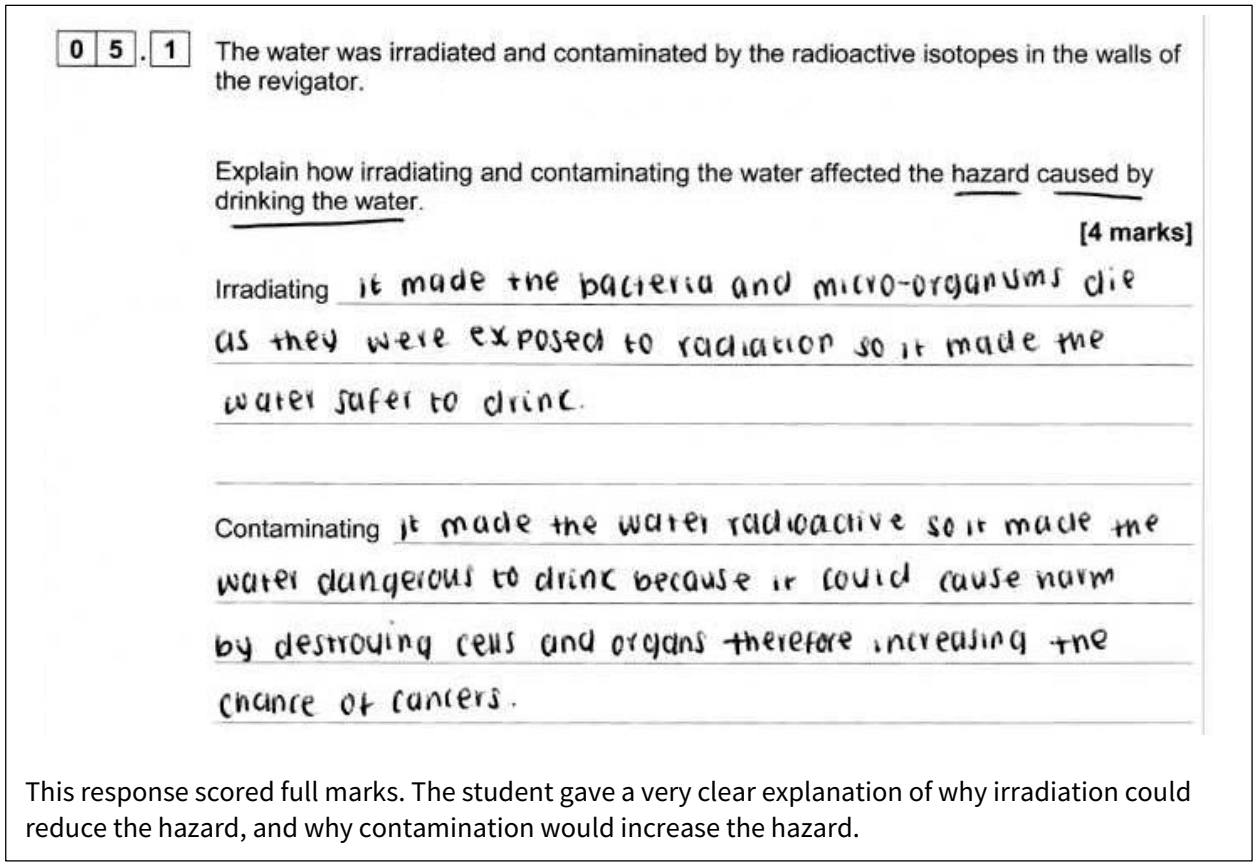
Answer 03 · Examiner comments

June 2024 | 8464/P/1H | Original Q5

Question 5 (standard/high & high demand)

05.1 Just over 40 % of students gained some credit on this question, but very few scored full marks. Many students showed confusion between a radioactive substance and the radiation emitted by that substance.

It was quite common for students to have some grasp of the meaning of contamination, but a surprisingly large proportion of students wrote answers referring very clearly to bacterial contamination of the water, rather than contamination by the radioactive isotopes.



0 5 . 1 The water was irradiated and contaminated by the radioactive isotopes in the walls of the revigator.

Explain how irradiating and contaminating the water affected the hazard caused by drinking the water.

[4 marks]

Irradiating it made the bacteria and micro-organisms die as they were exposed to radiation so it made the water safer to drink.

Contaminating it made the water radioactive so it made the water dangerous to drink because it could cause harm by destroying cells and organs therefore increasing the chance of cancers.

This response scored full marks. The student gave a very clear explanation of why irradiation could reduce the hazard, and why contamination would increase the hazard.

05.2 Less than half of all students selected the correct nuclear equation.

05.3 While nearly two-thirds of students gained some credit on this question, less than 5% scored all 4 marks. A lot of students demonstrated some knowledge of how activity changes with time, but there were also a number of misconceptions that were revealed by answers to this question.

Some students worked out that two half-lives would have passed for vanadium, but then went on to state that this meant that a ‘full life’ had passed so no more radiation would be emitted by the sample. Other students linked the mass number of the element with the half-life, and it was common to read answers suggesting that after two half-lives, vanadium-52 would have become vanadium-13.

It was also relatively common to see answers suggesting that the activity of a sample during a half-life would remain constant until the half-life was reached. At this point activity would then suddenly halve. This misconception was demonstrated by statements such as ‘Radon has not reached a half-life, so its activity has not changed’, which would still score marking point 1.

© 2024 AQA and its licensors. All rights reserved.

6.4.2.4 Radioactive contamination

Answer 03 · Examiner comments June 2024 | 8464/P/1H | Original Q5

A small number of students suggested that the half-life would change as time increased, and some students suggested that activity would increase with time.

0 5 . 3 **Table 2** shows the half-lives of radon-222 and vanadium-52.

Table 2

Isotope	Half-life
Radon-222	3.8 days
Vanadium-52	3.7 minutes

The scientist measured the radiation emitted by a sample of radon-222 and the radiation emitted by a sample of vanadium-52.

The scientist repeated the measurements 7.4 minutes later.

Explain how the activity of the radon-222 and vanadium-52 had changed after 7.4 minutes.

[4 marks]

Radon-222 the radon-222 has not changed at all as its half life is 3.8 days this means that it won't change until that point

Vanadium-52 3.7×2=7.4 => enough time for 2 half-lifes.

• from vanadium-52 -> Vanadium-13

The response about Radon demonstrates the misconception that activity remains constant, and then suddenly halves when the half-life is reached.

The response about vanadium illustrates the misconception that the mass number of an element will decrease by a factor of two for each half-life that passes.

05.4 About a third of students identified the process as peer review.

© 2024 AQA and its licensors. All rights reserved.