AQA GCSE Physics | 8463

SPECIFICATION POINT 4.4.3.3

Uses of nuclear radiation

Mark schemes and examiner comments

Tier	**Higher**
Question groups	**16**
Available paper years	**2007–2023**

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.

4.4.3.3 Uses of nuclear radiation

Answer 01 · Mark scheme

June 2007 | PHY1B | Original Q5 | Legacy

Five	**2**	**4**	**4**	**4**

Answer 02 · Mark scheme

June 2008 | PHY1BP | Original Q6 | Legacy

Six	**1**	**1**	**1**	**4**

4.4.3.3 Uses of nuclear radiation

Answer 03 · Mark scheme

Question 6

question	answers	extra information	mark
(a)(i)	3 fewer neutrons	accept fewer neutrons accept different number of neutrons do **not** accept different number of electrons	1
(a)(ii)	electron from the nucleus	both points needed	1
(a)(iii)	32 (days)	allow **1** mark for clearly obtaining 4 half-lives	2
(a)(iv)	has a **<u>much</u>** longer half-life little decay happened / still in the atmosphere	accept converse answers in terms of iodine-131 accept it has not reached one half-life yet accept it is still decaying	1 1
(b)	any **two** from: • some children developed TC before 1986 • some children (after 1986) that developed TC did not live in highly contaminated areas • the (large) increase can (only) be explained by (a large increase in) radiation as caused by Chernobyl • all areas would be contaminated (and raise the risk of TC) • no evidence (of effect) of other variables	marks are for reasons	2
(c)	People not exposed (to the radiation but who were otherwise similar)	accept people not affected (by the radiation)	1

Question 6 continues on the next page

PHY1H

Question 6 continued

question	answers	extra information	mark
(d)	any **two** from: • produce no pollutant / harmful gases • produces a lot of energy for a small mass (of fuel) **or** is a concentrated energy source • it is reliable **or** it can generate all of the time • produces only a small volume of (solid) waste	answers should be in terms of nuclear power and **not** why we should not use other fuels accept named gas or greenhouse gases do **not** accept no pollution accept amount for mass accept high energy density accept amount for volume	2
total			11

4.4.3.3 Uses of nuclear radiation

Answer 04 · Mark scheme

November 2008 | PHY1BP | Original Q7 | Legacy

Seven	**1**	**3**	**3**	**1**

Answer 05 · Mark scheme

March 2009 | PHY1BP | Original Q3 | Legacy

Three	**1**	**3**	**2**	**1**

4.4.3.3 Uses of nuclear radiation

Answer 06 · Mark scheme June 2009 | PHY1H | Original Q6 | Legacy

Question 6

question	answers	extra information	mark
6(a)(i)	gamma hardly ionises the air	accept does not ionise accept gamma radiation is not charged do **not** accept answers in terms of danger of gamma or other properties	1
6(a)(ii)	half-life (too) short	accept need frequent replacement 'it' refers to curium-242	1
6(a)(iii)	(two) fewer neutrons	accept different numbers of neutrons if a number is specified it must be correct do **not** accept more neutrons unless curium-244 is specified	1
6(b)(i)	gamma	accept correct symbol	1
6(b)(ii)	both absorbed by the metal / steel / weld	only scores if (b)(i) is correct accept cannot pass through the metal / steel / weld	1
6(c)(i)	put source into water at **one** point on bank see if radiation is detected in polluted area	accept the idea of testing different parts of the river bank at different times accept idea of tracing	1 1
6(c)(ii)	2.7 (days)	allow **1** mark for showing correct use of the graph	2
Total			**9**

4.4.3.3 Uses of nuclear radiation

Answer 07 · Mark scheme June 2011 | PHY1BP | Original Q7 | Legacy

Seven	**2**	**2**	**1**	**3**

Answer 08 · Mark scheme November 2011 | PHY1BP | Original Q4 | Legacy

Four	**3**	**4**	**4**	**3**

Answer 09 · Mark scheme November 2011 | PHY1BP | Original Q7 | Legacy

Seven	**3**	**2**	**3**	**4**

4.4.3.3 Uses of nuclear radiation

Answer 10 · Mark scheme

June 2012 | PH2HP | Original Q2 | Legacy

Question 2

question	answers	extra information	mark
2(a)(i)	1.25 (mSv)		1
2(a)(ii)	any **two** from: • (frequent) flying • living at altitude • living in areas with high radon concentrations • living in a building made from granite (blocks) • having more than the average number of X-rays or having a CT scan • working in a nuclear power station	accept stated occupation that involves flying accept a specific area, eg Cornwall accept more medical treatments accept any suggestion that could reasonably increase the level from a specific source	2
2(b)(i)	to be able to see the effect of exposure (to radon gas) **or** as a control	accept to compare (the effect of) exposure (with no exposure)	1
2(b)(ii)	increased levels of exposure increases the risk (of developing cancer) smoking increases the (harmful) effect of radon	accept exposure (to radon gas) increases the risk answers that simply reproduce statistics are insufficient	1 1
2(c)	LNT model – risk increases with increasing radiation (dose) level Radiation hormesis – low radiation (dose) levels reduce the risk	accept in (direct) proportion accept low doses increase the risk	1 1

Question 2 continues on the next page . . .

4.4.3.3 Uses of nuclear radiation

PH2HP

Question 2 continued

question	answers	extra information	mark
2(d)	two valid points made – examples: • animals have no choice and so should not be used • should not make animals suffer • better to experiment on animals than humans • experiments lead to a better understanding / new knowledge • experiments may lead to health improvement / cures for humans	results for animals may not apply to humans is insufficient	2
Total			**10**

4.4.3.3 Uses of nuclear radiation

Answer 10 · Mark scheme

June 2012 | PH2HP | Original Q2 | Legacy

PH2HP

Answer 11 · Mark scheme

June 2014 | PH2HP | Original Q6 | Legacy

6(a)	(same) number of protons	same atomic number is insufficient	1	AO1 2.5.1e
6(b)(i)	nuclei split	do **not** accept atom for nuclei / nucleus	1	AO1 2.6.1b
6(b)(ii)	(nuclear) reactor		1	AO1 2.6.1a
6(c)	beta any **one** from: • atomic / proton number increases (by 1) • number of neutrons decreases / changes by 1 • mass number does not change • a neutron becomes a proton	 accept atomic / proton number changes by 1 (total) number of protons and neutrons does not change	1 1	AO2 2.5.2d
6(d)	(average) time taken for number of nuclei to halve **or** (average) time taken for count-rate / activity to halve		1	AO1 2.5.2h

Question 6 continues on the next page . . .

4.4.3.3 Uses of nuclear radiation

Question 6 continued . . .

Question	Answers	Extra information	Mark	AO spec ref
6(e)(i)	6.2 (days)	Accept 6.2 to 6.3 inclusive allow **1** mark for correctly calculating number remaining as 20 000 **or** allow **1** mark for number of 80 000 plus correct use of the graph (gives an answer of 0.8 days)	2	AO2 2.5.2h
6(e)(ii)	radiation causes ionisation that may then harm / kill healthy cells	allow radiation can be ionising accept specific examples of harm, eg alter DNA / cause cancer	1 1	AO3 2.5.2g
6(e)(iii)	benefit (of diagnosis / treatment) greater than risk (of radiation)	accept may be the only procedure available	1	AO3 2.5.2g
Total			**11**	

4.4.3.3 Uses of nuclear radiation

Answer 11 · Mark scheme

June 2014 | PH2HP | Original Q6 | Legacy

Question	Answers	Extra information	Mark	AO spec ref

4.4.3.3 Uses of nuclear radiation

Answer 12 · Mark scheme June 2017 | PH2HP | Original Q2 | Legacy

Question	Answers	Extra information	Mark	AO / Spec. Ref.
2(a)(i)	15 (%)	accept an answer of 0.15 for both marks allow **1** mark for (total radiation dose =) 2 (.00)	2	AO2 2.5.2b
2(a)(ii)	any one from: • living at altitude • pilot or aircrew • mountaineer • (very frequent) flyer	accept any answer that involves living or working at a height above sea level spending more time outdoors is insufficient ignore references to ozone layer	1	AO2 2.5
2(a)(iii)	any one from: • nuclear power (stations) • nuclear weapons (testing) • nuclear accidents • X rays or CT scan	accept nuclear/radioactive waste accept nuclear bombs/fallout accept named accident eg Chernobyl or Fukushima accept radiotherapy or medical treatments involving radioactive sources nuclear activity/radiation is insufficient smoke detectors is insufficient industrial tracers is insufficient	1	AO1 2.5.2b
2(b)	(radioactive decay) is a random process	accept an answer in terms of background/radiation varies (from one point in time to another) readings taken in different locations is insufficient	1	AO1 2.5.2a

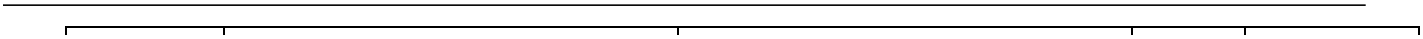
4.4.3.3 Uses of nuclear radiation

2(c)(i)	**ROUTE A** as thickness increases the count (in one minute) decreases **or** the count (in one minute) falls to background (because) beta radiation is absorbed by the aluminium **ROUTE B** it cannot be alpha because that would be stopped by aluminium (1) it cannot be gamma as that would not be reduced by aluminium (1)	Award highest score from **either** Route A or Route B accept count rate or reading for count (in one minute) accept (because) beta is stopped by aluminium	1 1	AO3 2.5.2e
2(c)(ii)	replace the aluminium with paper/card **or** remove the aluminium and increase the distance (between source and GM tube) will decrease the count (in one minute)	do not accept thin gold foil for paper second mark point is dependent on scoring the first mark point accept count rate or reading for counts (in one minute)	1 1	AO3 2.5.2e
Total			**9**	

4.4.3.3 Uses of nuclear radiation

Answer 12 · Mark scheme

June 2017 | PH2HP | Original Q2 | Legacy



4.4.3.3 Uses of nuclear radiation

Answer 13 · Mark scheme

June 2018 | 8463/1H | Original Q2

Question	Answers	Extra information	Mark	AO/ Spec. Ref
02.1	count rate = $\frac{819}{60}$ count rate = 13.65 corrected count rate = 13.35 (per second)	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 allow an answer of background = 0.30 × 60 = 18 (per minute) corrected count rate = 819 – 18 corrected count rate = 801 per minute	1 1 1	AO2 4.4.2.1 4.4.3.1
02.2	activity = 1250 × 180 activity = 225 000 (Bq)	an answer of 225 000 (Bq) scores **2** marks	1 1	AO2 4.4.2.1
02.3	yearly dose = 0.003 × 365 which is << 100 (mSv) **or** (well) below the lowest dose with evidence of causing cancer / harm	allow yearly dose = 1.095 (mSv)	1 1	AO3 4.4.3.1

4.4.3.3 Uses of nuclear radiation

Answer 13 · Mark scheme

June 2018 | 8463/1H | Original Q2

Question	Answers	Extra information	Mark	AO/ Spec. Ref
02.4	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**	

4.4.3.3 Uses of nuclear radiation

Answer 14 · Mark scheme June 2018 | 8463/1H | Original Q6

Question	Answers	Extra information	Mark	AO/ Spec. Ref
06.1	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
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	AO1 4.4.2.1
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	AO2 4.4.2.1
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	AO3 4.4.2.3

4.4.3.3 Uses of nuclear radiation

Answer 14 · Mark scheme

June 2018 | 8463/1H | Original Q6

Question	Answers	Mark	AO/ Spec. Ref
06.5	**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**

4.4.3.3 Uses of nuclear radiation

Answer 15 · Mark scheme

June 2022 | 8463/1H | Original Q7

Question 7

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

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.2	85 37	this order only	1 1	AO1 4.4.2.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.3	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 7		**8**

4.4.3.3 Uses of nuclear radiation

Answer 16 · Mark scheme

June 2023 | 8463/1H | Original Q5

Question 5

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

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.2	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.
05.3	2 half-lives 128.74 (s)	 allow 129 (s)	1 1	AO2 4.4.2.3

4.4.3.3 Uses of nuclear radiation

Answer 16 · Mark scheme

June 2023 | 8463/1H | Original Q5

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.4	nitrogen-18 greatest activity (so) greatest dose of radiation absorbed (per second)	 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 1 1	AO3 4.4.2.1 4.4.3.3

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

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.6	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

4.4.3.3 Uses of nuclear radiation

Answer 16 · Mark scheme

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.7	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.
05.8	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 5	17

4.4.3.3 Uses of nuclear radiation

Answer 16 · Examiner comments

June 2023 | 8463/1H | Original Q5

Question 5 (Standard/high Demand)

05.1 This question discriminated well with 43 % of students scoring 3 marks, 18 % of students scoring 2 marks and 17 % of students scoring 1 mark. There is evident confusion about the significance of the mass number and the atomic number and what they represent. Lots of students 'shot themselves in the foot' by making statements about incorrect numbers of particles. e.g. 'Number of neutrons in carbon-12 is different from carbon-14, it's 12 in carbon-12 and 14 in carbon-14', would score no marks. Any numbers given as examples had to be correct to score marks.

05.2 'Time for radioactivity to halve' was insufficient to score, which was a commonly seen answer. If a student specified 'the time to halve' they needed to be clear what was halving: mass, number of nuclei, activity, etc. 47% of students scored the mark for this question.

05.3 Students struggled to realise that if ¼ remained two half-lives had passed. Subsequently, any calculation they did scored no marks. 32% of students scored 2 marks. For only 1 mark to score the words '2 half-lives' needed to be seen, it was not sufficient to see the number '2'.

05.4 Most students incorrectly chose Fluorine-18 as causing the biggest risk, believing that its long half-life would cause the most harm. Students who chose nitrogen-18 were often imprecise in their explanation and used 'more radiation emitted' without indicating the time period over which the more radiation was emitted. 'Decays the fastest' was insufficient to score the 2nd marking point. Less than 1% of students scored 3 marks, 7% scored 2 marks and 15% scored 1 mark.

05.5 Students who had learned the definitions as stated in the specification scored well, with 18% of students scoring 2 marks. Many students were unclear of the difference between the two terms and gave vague answers about 'radiation being around you versus in you', which were insufficient to score. It was evident that many students don't appreciate that radioactive materials emit radiation and gave confused answers mixing the terms 'radiation' and 'radioactive'.

05.6 90% of students answered correctly, scoring a mark. The most common correct answer was 'cancer'. 'Death' was ignored as working with nuclear radiation would cause other specific harm before death occurred. 'Damage to tissues / organs' was also creditworthy, as they are made up of cells. As ionisation occurs at an atomic level, this was not sufficient to score a mark. A commonly seen incorrect answer was 'ionises cells'.

05.7 38% of students scored 2 marks on this question, while 3% of students scored 1 mark. Students who didn't mention alpha radiation / particles would not have scored marks. Some students thought that standing close to the radiation detector would help to rule out radiation due to background radiation, which was not creditworthy.

05.8 82% of students scored 3 marks usually for using the first method given in the mark scheme. Some students calculated 144 (days) but thought they had calculated hours so divided by 24 and wrote an answer of 6. They scored 2 marks, as their final answer was treated as a unit error.

4.4.3.3 Uses of nuclear radiation

AQA

GCSE
PHYSICS

8463/1H: Paper 1 (Higher tier)
Report on the Examination

8463
June 2022

Version: 1.0

4.4.3.3 Uses of nuclear radiation

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4.4.3.3 Uses of nuclear radiation

General

Grade 4-5 calculation questions ask for students to recall an equation, before using it in a subsequent calculation. In the 2022 series, students were given an Equations Sheet which had all the equations printed on it. Subsequently, the performance on the more straightforward calculations has improved on previous years.

The multistep calculations targeted at candidates working at grades 8-9, questions **09.1** and **10.1**, were well attempted with many students answering correctly. Of these two questions, students were slightly more successful on question **09.1** with about 55% of students scoring full marks, whereas for question **10.1** approximately 45% of students scored full marks.

Question **02.1** was generally well attempted and students who had carried out the density required practical had an advantage over those who hadn't. For this question, about 35% of students scored 6 marks and approximately 25% of students scored 5 marks.

Handwriting continues to be a problem for a number of students, making it very difficult for examiners to read what has been written. Students who have handwriting that is difficult to read may benefit from a scribe or from word processing their answers in exams.

Question 11

Due to incorrect Advance Information guidance being issued for this question, and to avoid students being disadvantaged, Question 11 was discounted and all students were awarded full (9) marks.

Levels of demand

Questions are set at three levels of demand for this paper:

- **Standard demand** questions are designed to broadly target grades 4–5.
- **Standard/high demand** questions are designed to broadly target grades 6–7.
- **High demand** questions are designed to broadly target grades 8–9.

A student's final grade, however, is based on their attainment across the qualification as a whole, not just on questions that may have been targeted at the level at which they are working.

Question 1 (Standard demand)

01.1 About 55% of students scored 2 marks. The unit conversion caused a problem for many students and powers of 10 errors were frequently seen. A correct calculation using an incorrectly or not converted value for power would score 1 mark.

01.2 Students were generally successful at answering this question with approximately 40% scoring 2 marks and about 50% scoring 1 mark. Most students wrote variations of the first and third bullet points in the markscheme. A number of students wrote that the turbines may be broken, which was enough to score a mark for the idea of maintenance.

01.3 'Turbine will rotate faster' was insufficient to score a mark. 'Rotate more smoothly' was not enough to score the 'less friction' mark. Students who stated that 'no energy was wasted' did not score the second marking point. Approximately 35% of students scored 3 marks, 35% of students scored 2 marks and 20% of students scored 1 mark.

01.4 About 30% of students scored 2 marks, while approximately 50% of students scored 1 mark. Many students answered in terms of 'saving energy' which was insufficient. Other students answered in terms of absolute statements which did not score, 'energy efficient appliances waste no energy' for example.

Question 2 (Standard demand)

02.1 Generally very well answered with about 35% of students gaining 6 marks and 25% scoring 5 marks. Students were told that this required practical would appear in the 2022 series via the Advance Information. A number of students quoted the density equation incorrectly, although this was given on the Equations Sheet for the 2022 series. There were extremely few students who didn't attempt the question and less than 1% of students who attempted the question scored zero.

02.2 Approximately 85% of students answered this question correctly. Of the incorrect answers seen, a significant proportion gave the maximum and minimum values the wrong way round. Another common mistake was to write maximum: 2.55 and minimum 0.10, which showed a clear misunderstanding of expressing an uncertainty.

02.3 About 95% of students answered this question correctly.

02.4 Approximately 45% of students scored 2 marks and 40% scored 1 mark. 'In case an error / mistake was made the first time' was insufficient. 'To check the repeatability of the data' was ignored, as this wouldn't improve the accuracy of the data. 'Get rid of anomalies' was assumed to mean 'remove anomalies', but 'stops anomalies from occurring' did not score. Likewise 'stops random errors' did not score.

Question 3 (Standard demand)

03.1 Over 99% of students answered this question correctly as they had all the Physics equations on the Equations Sheet for the 2022 series.

03.2 Nearly 95% of students answered this question correctly. In this series all students were given all the equations on the Equations Sheet. The first mark is for the substitution into the equation as it appears on the equations sheet. Some students failed to score any marks by incorrectly rearranging the equation, then substituting into the incorrectly rearranged equation.

03.3 Over 99% of students answered this question correctly as they had all the Physics equations on the Equations Sheet for the 2022 series.

03.4 95% of students answered this question correctly. In this series all students were given all the equations on the Equations Sheet. The first mark is for the substitution into the equation as it appears on the Equations Sheet. Some students failed to score any marks by incorrectly rearranging the equation, then substituting into the incorrectly rearranged equation.

Question 4 (Standard/High demand)

04.1 A large number of students found it difficult to identify the independent and dependent variables in the investigation that was described. Control variables appeared often in students' answers. 'Temperature change' seemed to be the most common incorrect answer for the dependent variable. About 50% of students scored 2 marks and approximately 35% of students scored 1 mark.

04.2 65% of students answered correctly. The most common incorrect answer was 87.4 °C.

04.3 About 35% of students answered this question correctly. Common incorrect answers referred to the resolution, or just repeated the question and said 'difficult to read' which was insufficient.

04.4 Approximately 75% of students scored 3 marks and about 10% of students scored 2 marks. Power of 10 errors were common and usually resulted in 2 marks being scored for an incorrectly or not converted value of energy.

04.5 Many students found relating the time for the temperature to decrease to thermal conductivity difficult. About 15% of students scored 2 marks, while 40% scored 1 mark. Answers in terms of good / bad insulators were insufficient to score a mark.

Question 5 (Standard/High demand)

05.1 Approximately 45% of students scored 1 mark, with about 5% of students scored 3 marks. Around 30% of students scored no marks. The first marking point of this explanation was most likely to score, the third marking point was least likely to score.

05.2 About 30% of students scored all 3 marks for this explanation. 10% of students scored 2 marks and 10% scored 1 mark. A lot of student answers were not creditworthy, with mixed up descriptions of ion transfer, electron transfer, proton transfer, protons weighing more than electrons and transfer of electrons increasing the mass of the rod on the balance. As a result about 50% of students scored zero.

05.3 Approximately 60% of students scored the mark. Some students evidently did not know what a zero error was. Answers like 'it means there is no error' being a good example of this. Some answers were insufficient, 'the actual mass of the rod is not required' being not enough to score the mark. 'Weight' was allowed for 'mass' when used correctly as the reading on the balance does depend on the weight of the object. An answer of 'only the change in weight was needed' would have scored the mark.

05.4 Some very good explanations were seen and about 10% of students scored all 3 marks. The first marking point was least likely to score. The third marking point needed to be linked to the second marking point before it could be scored.

Question 6 (Standard/High demand)

06.1 This question discriminated well between students. About 15% scored 4 marks with 20% gaining 3 marks. The first two marking points were most commonly scored. Students who said that 'no energy was lost' as a consequence of the step-up transformer's effect did not score the third marking point.

06.2 Approximately 55% of students scored 2 marks, while 15% of students scored 1 mark. Students who scored no marks usually confused the quantity that was decreased (pd) with the quantity that increased (current). Some student answers lacked technical accuracy referring to energy, power or charge incorrectly.

06.3 Two thirds of students scored 4 marks for this calculation, whereas about 20% of students scored 3 marks. A common mistake was to try to multiply the answer by the number of seconds in a day, which would probably only score the significant figure mark if correct, as the Physics equations were applied incorrectly.
Common mistakes were to round the answer to 1 400 000 000 C, which would score 3 marks if the full s.f. answer was seen, or round the answer to 141, which would score 3 marks for the supporting calculations if seen. A common error was to miscount the number of zeroes, so would only score 3 marks.

Question 7 (Standard/High demand)

07.1 54% of students could state what an alpha particle consists of. The list principle was applied when students wrote '2 protons and 2 neutrons – a helium atom', which did not score.

07.2 65% of students completed the nuclear equation correctly, scoring 2 marks, whereas 24% scored just 1 mark.

07.3 Students generally made good attempts to answer this question and marking points 1, 2 and 4 were seen most often. To score the 5th marking point students need to make a comparative statement, internal versus external damage. The third marking point was least likely to score, as students rarely referred to dose or the living cells / tissues / organs inside the body. Some students incorrectly thought that ionisation was a process that happened to cells, rather than atoms, so often didn't score the fifth marking point for this reason. Very few students scored 5 marks and the question discriminated well between students of differing ability.

Question 8 (Standard/High demand)

08.1 About 90% of students gave the correct measuring instrument. While it wasn't seen often, an answer of a 'volumetric pipette' was also creditworthy. 'Pipette' was insufficient.

08.2 Around 90% of students correctly identified the hazard in the investigation.

08.3 For this calculation, about 45% of students scored 5 marks and 20% of students scored 4 marks. A common mistake was to calculate *L* using one of the masses given in the question, rather than the change in mass. The resulting numerical answer would score zero as the equation was not being used correctly.

08.4 About 15% of students scored 2 marks for this explanation and 10% of students scored 1 mark. Many students reached incorrect conclusions and many students simply reworded the information given in the question.

08.5 7% of students scored 2 marks and 3% of students scored 1 mark. Many students reached incorrect conclusions and many students reworded the information given in the question without adding to it.

4.4.3.3 Uses of nuclear radiation

Question 9 (High demand)

09.1 Approximately 55% of students scored 5 marks, but in the 2022 series students were provided with an Equations Sheet with all the equations. A commonly seen answer was 73 500, which scored 4 marks for not converting the height into metres.

09.2 5% scored 2 marks and about 30% scored 1 mark. Many students failed to score a mark by pointing to the 'inaccuracy of the measured mass / height / gravitational field strength', or referring to the measurements as being 'low resolution'. 'Mass may have been greater than 60 kg' or 'time may have been longer / shorter than 1.40 seconds' were other common incorrect answers.

09.3 About 75% of students identified the correct conclusion.

Question 10 (High demand)

10.1 About 45% of students scored 6 marks for this extended calculation, but in the 2022 series students were provided with an Equations Sheet with all the equations. Therefore, students were supported when it came to attempting this question. With an alternative approach using equations from paper 2, students' answers were marked on whichever approach brought them closest to the correct final answer. An answer of 6 m/s with no supporting working did not score full marks as students could achieve this answer by multiplying the spring constant and the extension together, which would give them the maximum force acting on the toy aeroplane.

10.2 About 65% of students scored the mark. The most common incorrect answers seen were gravitational potential or elastic potential.

10.3 Approximately 20% of students scored a mark. Many students failed to score a mark because they gave a factor without a specific change e.g. 'extension of spring', rather than 'increase the extension of the spring'.

Question 11 (High demand)

Due to incorrect Advance Information guidance being issued for this question, and to avoid students being disadvantaged, Question 11 was discounted and all students were awarded full (9) marks.

4.4.3.3 Uses of nuclear radiation

Use of statistics

Statistics used in this report may be taken from incomplete processing data. However, this data still gives a true account of how students have performed for each question.

Mark Ranges and Award of Grades

Grade boundaries and cumulative percentage grades are available on the Results Statistics page of the AQA Website.