Radioactive Emissions

Q1.(2018)

B ✓

Q2.(2018)

C ✓

Q3.(2018)

Same element / atoms with same atomic number/number of protons ✓ but different mass numbers / different numbers of neutrons ✓	**2**	**2 × 1.1**	**IGNORE** any mention of electrons

Q4.a(2018)

Prevents (gamma) radiation escaping /To reduce exposure of pupils or himself to radiation ✓	**1**	**1.2**	**ALLOW** (gamma) radiation only goes in one direction **ALLOW** Blocks radiation/gamma **DO NOT ALLOW** just waves or energy

Q4.b(2018)

Gamma ✓	**3**	**2.1**	
Any two from: • No drop with paper – so not alpha ✓		**2 x 3.1a**	
• No significant drop with Al – so not beta ✓			**ALLOW** small drop in count rate with Al may be due to random nature of radiation
• Significant drop with Pb / radiation passes through Al ✓			**ALLOW** gamma is only stopped by thick lead/goes through paper and Aluminium (some through lead) absorbers
• Count rate reached background reading ✓			

Q5.(2019)

A ✓

Q6.(2019)

Unstable nucleus ✓	**1**	**1.1**	**DO NOT ALLOW** unstable isotopes **ALLOW** too many /few neutrons

Q7.a(2019)

$^{32}_{15}P \rightarrow {}^{32}_{16}S + {}^{0}_{-1}\beta$

Atomic/proton number of S: 16 ✓

Mass/nucleon number of ß: 0 ✓

Q7.b(2019)

Use a Geiger counter / G-M tube as detector ✓ **AND** **Any three from:** place paper in front of source ✓ no significant drop in count rate/ particles passing through ✓ place (thin) aluminium in front of source ✓ drop in count rate/particles do not pass through ✓ reading should drop to background / no further drop with lead ✓	**4**	**4 x 2.2**	**ALLOW** marks from diagram **ALLOW** thin metal or any suitable material **DO NOT ALLOW** lead

Q7.c(2019)

Neutrons / alpha particles / helium nuclei ✓

Q8.a(2019)

Any two from: today contains (electron) shells / orbits / ORA ✓ today contains a nucleus / ORA ✓ today nucleus contains protons and neutrons ✓ in 1902 used plum pudding model ✓ in 1902 positive mass containing electrons spread through it / AW ✓ in 1902 there is a cloud of positive charge ✓	**2**	**2 × 1.1**	 **ALLOW** positive charge in nucleus **For TWO marks** Today has electrons orbiting a nucleus✓✓

Q8.b(2019)

Technology has advanced / new experimental evidence available / new explanations available /more research taking place/ AW ✓	**1**	**1.1**	e.g. new/better equipment available

Q9.a(2019)

Mean is all the numbers added together and then divided by the total number ✓ Mode is the number which occurs most often **AND** 14 ✓ Median is the middle number **AND** 14 ✓	**3**	**3 × 1.2**	**ALLOW** Mean is the average **AND** 14.3 / 14 **ALLOW** the number that occurs twice/most frequent/most popular / AW **AND** 14 **ALLOW** method to find the median **AND** 14 if no other marks awarded **ALLOW** correct values for mode **AND** median for one mark

Q9.b(2019)

Half-life = 4 (throws) ✓	**1**	**2.1**	**IGNORE** decimal answers that round to 4

Q10.(2020)

D

Q11.a(2020)

FIRST CHECK THE ANSWER ON ANSWER LINE
If answer = 705 (Bq) award 1 mark

(Mean = (701+704+708+707)÷4)
Mean = 705 (Bq) ✓

Q11.b(2020)

No (pattern) / random values / fluctuates/AW ✓ (Radioactive decay) is a random process ✓	**2**	**3.2b** **1.1**	**ALLOW** both increased and decreased repeatedly

Q12.a(2020)

They have different number of neutrons **and** same number of protons ✓	**1**	**2.1**	**ALLOW** different mass number **and** same proton number

Q12.b(2020)

Stays the same / unchanged ✓

Q13.a(2020)

Time taken for number of (radioactive) nuclei / activity / amount of isotope / mass / count rate to halve ✓	**1**	**1.1**	**DO NOT ALLOW** atoms

Q13.b(2020)

FIRST CHECK THE ANSWER ON ANSWER LINE
If answer = 458 (years) award 1 mark

(Activity halves every 458 years)
Half life = 458 (years) ✓

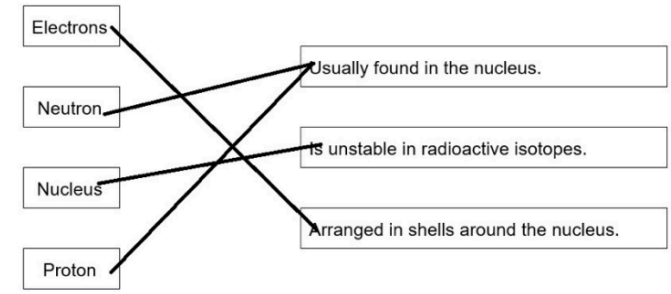
Q13.c(2020)

Isotope C ✓	**3**	**3.2a**	
Need an alpha emitter as alpha cannot penetrate smoke / beta will not be blocked by smoke / AW ✓		**3.1b**	**ALLOW** Alpha is highly ionising (so can ionise air) **ALLOW** Alpha is <u>least</u> penetrating
Need long half-life so smoke alarm doesn't need replacing too often / ORA / AW ✓		**3.1b**	**ALLOW** this marking point if B chosen

Q14.(2021)

A

Q15.a(2021)



3	**3 × 1.1**	All 4 correct ✓✓✓ Any 3 correct ✓✓ Any 2 correct ✓

Q15.b(2021)

Stays the same / AW ✓

Q15.c(2021)

<u>Lead</u> (lined metal container) ✓	**1**	**2.1**	**ALLOW** concrete

Q15.d(2021)

Place X near object (but not touching it) ✓
Allow radiation from X to reach object / AW ✓

Q15.e(2021)

Plastic bottle **AND** Does not break easily / is waterproof /secure lid/ AW ✓	**1**	**3.1b**	**BOTH** needed **ORA** for cardboard box

Q15.f(2021)

Alpha ✓

Q15.g(2021)

50 (%) **AND** 25 (%) ✓	**1**	**2.2**	**BOTH** needed

Q15.h(2021)

Because the amount halves after 5 days / AW✓

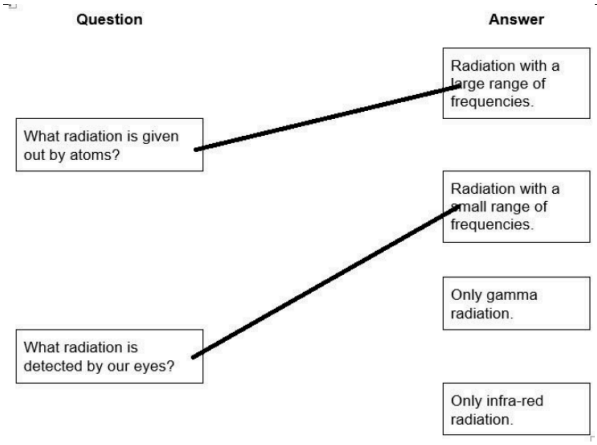
Q16.(2022)

A ✓

Q17.(2022)

$^{238}_{92}U$ in first box ✓ $^{4}_{2}\alpha$ **AND** $^{234}_{90}Th$ in second or third box ✓	**2**	**2 × 1.1**	**ALLOW** answers in either order **ALLOW** a for alpha symbol **ALLOW** Correct symbols in correct places with one or more missing or incorrect numbers for 1 mark

Q18.(2022)



One mark for each line ✓✓	**2**	**2 × 1.1**	More than one line from a Question box CON

Q19.(2022)

The nucleus contains protons and neutrons ✓ The nucleus has a positive charge ✓	**2**	**2 × 1.1**	Each correct tick = 1 mark Three ticks with two correct = 1 mark Three ticks with one correct = 0 marks More than three ticks = 0 marks

Q20.(2022)

As time increases, mass decreases / ORA ✓ (Mass decreases) at a decreasing rate / decreasing gradient ✓	**2**	**2 × 3.1a**	**ALLOW** inversely related / inversely proportional **IGNORE** negative correlation **ALLOW** at the beginning the mass decreases and then it slows down **ALLOW** marking points combined e.g. mass decreases at a decreasing rate / as time goes on the less the mass decreases / as time continues it loses mass more slowly = 2 marks **IGNORE** references to half-life or activity

Q21.(2023)

B

Q22.(2023)

Please refer to the marking instructions on page 4 of this mark scheme for guidance on how to mark this question. **Level 3 (5–6 marks)** Detailed description of a difference between alpha, beta or gamma radiation. **AND** Correctly identifies the type of radiation emitted giving a valid logical explanation based on the data table *There is a well-developed line of reasoning which is clear and logically structured. The information presented is relevant and substantiated.* **Level 2 (3–4 marks)** Clear description of a difference between alpha, beta or gamma radiation. **AND** Identifies the type of radiation emitted or not emitted giving some valid explanation based on the data table *There is a line of reasoning presented with some structure. The information presented is relevant and supported by some evidence.* **Level 1 (1–2 marks)** Basic description of a difference between alpha, beta or gamma radiation. **OR** Identifies the type of radiation emitted or not emitted with little or no reference to the data *There is an attempt at a logical structure with a line of reasoning. The information is in the most part relevant.*	**6**	**2 × 1.2** **2 × 3.2b** **2 × 3.2a**	Indicative content may include: **AO1.2 – Demonstrates knowledge and understanding of scientific ideas relating to alpha, beta and gamma** • alpha and beta are particles • gamma is a (electromagnetic) wave/ray • alpha is a helium nucleus / made of protons and neutrons • beta is a (fast-moving) electron • alpha has a mass of (+)4 • alpha has a charge of +2/positive • beta has zero/negligible mass • beta has a charge of -1/negative • gamma has no mass and no charge/ • alpha is highly ionising • gamma is weakly ionising • alpha stopped by paper/least penetrating • beta is stopped by aluminium • gamma reduced by lead /most penetrating • there is background radiation **AO3.2a Analyse information and ideas to interpret the data table** • (cannot be alpha) – radiation from source not absorbed by paper • (must be beta) – radiation from source penetrates paper • (must be beta) – radiation from source is absorbed by 4mm aluminium

- (cannot be gamma) – radiation from source is (all) absorbed by 4mm aluminium
- (cannot be gamma) – none of the source is absorbed by lead

AO3.2b – Analyse information and ideas to draw conclusions about the type of nuclear radiation emitted

- cannot be alpha – (radiation from source not absorbed by paper)
- must be beta – (radiation from source penetrates paper / is absorbed by 4mm aluminium)
- cannot be gamma – (radiation from source is (all) absorbed by 4mm aluminium / none of the source is absorbed by lead)

Q23.(2024)

D

Q24.(2024)

C

Q25.a(2024)

$^{7}_{3}Li$ contains 3 protons and 4 neutrons ✓

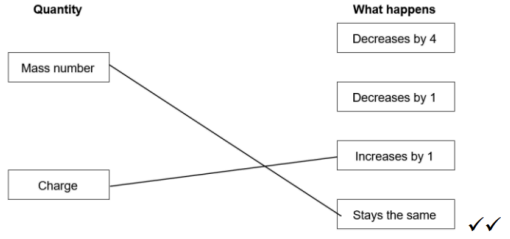
$^{14}_{7}N$ and $^{15}_{7}N$ are isotopes ✓

The atomic number of nitrogen is 7 ✓

Q25.b(2024)

Alpha particles ✓

Q25.c(2024)



✓✓

2	**2 × 1.1**	Correct answer for mass number ✓ Correct answer for charge ✓ **DO NOT ALLOW** more than one line from or to each box

Q25.d(2024)

(For nucleus/atom) to become stable✓	1	1.1	**ALLOW** (nucleus/atom) is unstable **IGNORE** references to electrons

Q25.e(2024)

First check the answer on the answer line
If answer = 15 (days) award 2 marks

2 half-lives (= 30 days) ✓

1 half-life = 15 (days) ✓