Mark Scheme

Q1.

	Answer	Acceptable answers	Mark
	☒ **D**		**(1)**

Q2.

	Answer	Acceptable answers	Mark
	☒ **B** becquerel		**(1)**

Q3.

	Answer	Acceptable answers	Mark
	☒ **A** gamma radiation		**(1)**

Q4.

	Answer	Acceptable answers	Mark
	P and M OR M and P OR N and Q	one mark for a pair	**(1)**

	OR Q and N		

Q5.

	Answer	Acceptable answers	Mark
(i)	Any **two** of: Gamma is a wave (1) Alpha is a helium nucleus (1) Alpha is charged (1) Alpha has a mass (1) Gamma penetrates further/ highly (1) Gamma weakly ionising (1) Gamma travels faster (1)	Reverse arguments em radiation Gamma has no charge Gamma has no mass examples of penetrating power alpha highly ionising ignore vague comments eg stronger Ignore uses and dangers	**(2)**

Q6.

	Answer	Acceptable answers	Mark
	{atomic /proton} number drops by 2 **and** {mass/nucleon} number by 4 (1) (which is) alpha decay (1)	2 protons **and** 2 neutrons are lost 92 → 90 **and** 238 → 234 helium nucleus given off (which is) alpha particle	**(2)**

Q7.

	Answer	Acceptable answers	Mark
(i)	alpha	Alpha ray, alpha particle, α Ignore capital letters	**(1)**
(ii)	A description including two of one increases as other increases (1)	 the particles with higher energy travel	**(2)**

	rate of increase is in the range from 1.17 to 1.33 (cm/MeV) (1) range gradually increases more with energy (1)	further accept values quoted from graph not (quite) linear/not proportional /curves upwards accept values quoted from graph	

Q8.

Question Number	Answer	Additional guidance	Mark
	a description to include: 1. put rock(s) in front of/near tube (1) 2. measure (count rate) separately for the two different rocks (1) 3. measure each count for the same time period (1) 4. keep source-detector distance the same for both rocks (1) 5. take (into account)/measure background count (1) 6. repeat readings and take average(s) (1)	not 'in' tube keep rocks apart	**(4)** AO 2 2

Q9.

Question Number	Answer	Acceptable answers	Mark
(i)	**C** 		**(1)**

Question Number	Answer	Acceptable answers	Mark
(ii)	An explanation linking any three of the following:- positron has a positive (charge) (1) electron has a {negative (charge) / opposite charge(s) } (1) these charges cancel out (1) gamma rays /waves have no charge (1)	 positron has +1 / +e (charge) positron charge is + electron has -1 / -e (charge) electron charge is – neutralise / overall charge is zero Accept for three marks: electron and positron have equal and opposite charges which cancel out.	**(3)**

Question Number	Answer	Acceptable answers	Mark
(iii)	An explanation linking : positron and electron have mass(before the annihilation) (1) gamma (rays produced by annihilation) have energy (1) (the equation shows)	 mass (of particles) becomes energy of gamma (rays) (2) all the mass before the collision becomes the energy of the gamma (rays) after the particles have been annihilated (2) $E=mc^2$ reference (1) explained will get the other (1)	**(2)**

Q10.

			Indicative Content
QWC		*	An explanation including some of the following ideas **Need for measurement (N)** Background radiation • is {always present/all around us} • has (natural) source(s) exemplified by space, r rocks, food, nuclear/medical sources etc. • would give false reading in experiment **How and why to measure(H)** Background radiation measurement • is taken at site of experiment **because**it is dif different places • is taken with all apparatus **except**source in pl • is taken before and after **because**{it can char / they need an average} • {must be worked out for same time as (or long experiment / rate found} **so**analysis is simpler • It is {taken several times/ averaged} **because** **Analysis (A)** Background radiation measurement • must be subtracted from {measurements with count rate}

Level	**0**	No rewardable content
1	**1 - 2**	• A limited explanation mentioning any **two**from N or **one**from H or A e.g. Background comes from space and rocks.(N) It is there all the time. (N) OR Readings for background must be repeated because they are random. (H) OR Background must be taken away from all other readings (A) • the answer communicates ideas using simple language and uses limited scientific terminology • spelling, punctuation and grammar are used with limited accuracy
2	**3 - 4**	• A simple explanation ***linking***aspects of two ideas i.e. **N**+ **H**OR **N**+ **A** OR **H**+ **A** e.g Take readings without source (H) and subtract them from the main readings with source present.(A) OR It should be taken several times because it is random (H)so that the average can be subtracted from the main readings (A) • the answer communicates ideas showing some evidence of clarity and organisation and uses scientific terminology appropriately

		• spelling, punctuation and grammar are used with some accuracy
3	**5 - 6**	• A detailed explanation ***linking*** **A** with EITHER N + an idea from **H** OR two or more ideas from **H** e.g. Background radiation is there all the time. (N) You need to take readings at the place where you will do the experiment and with all the apparatus set up except the source because BR changes from place to place.(H) Then you should subtract background readings from the main experimental readings.(A) OR Take several readings of count rate for averaging since the effect is random (H) and make sure that they are taken in the same place.(H) Then subtract from readings in main experiment.(A) • the answer communicates ideas clearly and coherently uses a range of scientific terminology accurately • spelling, punctuation and grammar are used with few errors

Q11.

Question Number	Answer	Mark
	Answers will be credited according to candidate's deployment of knowledge and understanding of the material in relation to the qualities and skills outlined in the generic mark scheme. The indicative content below is not prescriptive, and candidates are not required to include all the material which is indicated as relevant. Additional content included in the response must be scientific and relevant. **AO3 Strand 2a and 2b (6 marks)** • shows some idea that the data can support arguments about alpha, beta and gamma radiation being present • argues that there is some evidence that alpha might be emitted (count rate going down with paper interposed) • argues that there is a lot of evidence that beta parti-cles are emitted (count rate goes down a lot when the aluminium is inserted) • argues that there might be some gamma getting through (lead stopping everything apart from gamma) OR that with the lead present the count rate has gone down to a level consistent with background, so no gamma was present a level 3 answer will use data effectively	**(6)** AO 1 1

Level	Mark	Descriptor
	0	• No rewardable material.
Level 1	1-2	• Deconstructs scientific information but understanding and connections are flawed. An unbalanced or incomplete argument that provides limited synthesis of understanding. • Judgements are supported by limited evidence. (AO3)
Level 2	3-4	• Deconstructs scientific information and provides some logical connections between scientific concepts. An imbalanced argument that synthesises mostly relevant understanding, but not entirely coherently. • Judgements are supported by evidence occasionally. (AO3)
Level 3	5-6	• Deconstructs scientific information and provide logical connections between scientific concepts throughout. A balanced, well-developed argument that synthesises relevant understanding coherently. • Judgements are supported by evidence throughout. (AO3)

Q12.

Question Number	Answer	Mark
	Answers will be credited according to candidate's deployment of knowledge and understanding of the material in relation to the qualities and skills outlined in the generic mark scheme. The indicative content below is not prescriptive and candidates are not required to include all the material which is indicated as relevant. Additional content included in the response must be scientific and relevant. **AO3 and AO2 (6 marks)** **AO3** • most go straight through to P • some are deflected through small angles to Q • few have deflections greater than 90° to R • or are even reflected (bounce back off the foil) to R **AO2** • alpha positive is repelled by positive nucleus • atom being mostly empty space • atoms have a small nucleus • nucleus has a big mass / density • +ve charge concentrated into a very small space	**(6)**

Level	Mark	Descriptor
	0	• No awardable content
Level 1	1–2	• Interpretation and evaluation of the information attempted but will be limited with a focus on mainly just one variable. Demonstrates limited synthesis of understanding. (AO3) • The explanation attempts to link and apply knowledge and understanding of scientific ideas, flawed or simplistic connections made between elements in the context of the question. (AO2)
Level 2	3–4	• Interpretation and evaluation of the information on both variables, synthesising mostly relevant understanding. (AO3) • The explanation is mostly supported through linkage and application of knowledge and understanding of scientific ideas, some logical connections made between elements in the context of the question. (AO2)
Level 3	5–6	• Interpretation and evaluation of the information, demonstrating throughout the skills of synthesising relevant understanding. (AO3) • The explanation is supported throughout by linkage and application of knowledge and understanding of scientific ideas, logical connections made between elements in the context of the question. (AO2)

Summary for guidance

Level	Mark	Additional Guidance	General additional guidance – the decision within levels Eg - At each level, as well as content, the scientific coherency of what is stated will help place the answer at the top, or the bottom, of that level.
	0	No rewardable material.	
Level 1	1–2	Additional guidance unlinked statement from the diagram or table or knowledge of the atom	Possible candidate responses most particles go to P *(from table)* OR particles refract/bend to Q *(from diagram)*
Level 2	3–4	Additional guidance One link between any TWO of diagram, table, knowledge about atoms.	Possible candidate responses Most particles go straight through (the gold) to P *(from table and diagram)* OR Most particles go to P which means an atom is mainly space *(from table and knowledge)* OR particles are reflected because there is a nucleus (*diagram and knowledge)*
Level 3	5–6	Additional guidance One link between diagram **AND** table **AND** knowledge about atoms	Possible candidate responses Most particles go straight through (the gold) to P which means an atom is mainly space OR A few particles reflected back to R which means an atom has a nucleus

Q13.

	Answer	Acceptable answers	Mark
(a)	A		**(1)**
(b)	axes labelled correctly With label or unit (1) correct shaped smooth curve (1) line does not reach zero activity (1)	activity / Bq / count rate ignore radioactivity time/ seconds/ any time unit	**(3)**
(c)(i)	Idea of 2 half-lives (1) 11 400 = 2 × 5700 Idea of halving activity twice (1) 0.55 × 2 × 2 Calculation (1) 2.2 (Bq)	11 400 / 5700 = 2 2.2 (Bq) for three marks	**(3)**
(c)(ii)	Explanation linking two of: • Background radiation affects the measurement (1) • Needs to be subtracted from readings (1) • Background radiation is variable (1) • Background radiation needs to be averaged (1)	accept interfering / including varies with place/time/random nature repeating test improves reliability	**(2)** **t**
(c)(iii)	One relevant idea: (New method) more accurate (1) Hard to measure a small activity (1) Background radiation affects readings (1) Need to find difference of two small quantities (1) Can test smaller samples (1)	ignore better method/results / more reliable difficult to distinguish between the reading and background	**(1)** **grad**

Total for question = 10 marks

Q14.

Question Number	Answer	Acceptable answers	Mark
(a)(i)	proton(s) (1)	NOT photon	**(1)**

Question Number	Answer	Acceptable answers	Mark
(a)(ii)	electron(s) (1)		**(1)**

Question Number	Answer	Acceptable answers	Mark
(b)(i)	evidence of halving activity eg line on graph at 80 (Bq) or two lines at, say, 100 and 50. (1) 8 (days) gains both marks (2)	accept halving in answer space e.g. 160 -> 80 or 80 -> 40 or 160 ÷ 2 = 80 NOT 160 ÷ 40 or 131 ÷ {2 or 4} or 40 ÷ 2 (unless clearly an activity)	**(2)**

Question Number	Answer	Acceptable answers	Mark
(b)(ii)	idea of two half-lives (1) but, 16 (days) gains both marks (2)	halving of 800 twice, e.g. 400 AND 200 seen Allow ECF from graph eg allow half-life from graph x 2 for both marks	**(2)**

Question Number		Indicative Content	Mark
QWC	* **(c)**	A discussion including some of the following points Advantages - (currently) large resources of **fuel**/ **fuel** (reserves) will last a long time - (Produces) large amount of (electrical) energy/electricity - Does not produce (much/any) carbon dioxide - Does not produce (much/any) sulphur dioxide - Does not add to global warming/climate change - Good safety record (under normal operating conditions) - Only small amount of fuel needed to produce large amount of energy/electricity - Reliable supply/provides continuous supply of electricity (for a long time) - Reduces dependence on foreign supplies of energy - Conserves fossil fuel supplies - (Spent) fuel can be processed (to produce fuel for other reactors) - Provides employment/jobs Disadvantages - Produces nuclear/radioactive {waste/materials} - nuclear/radioactive waste/materials can cause mutations in DNA/cells/people/animals - Non- renewable (energy source) - Difficulties in transporting nuclear/radioactive waste/material - Difficulty in (safely) storing/disposing nuclear waste/material - Nuclear accidents (can) pollute large areas - Accept named example of accidents eg Fukishima, Chernobyl, 3-mile island - Mining and processing fuel both produce large amounts of carbon dioxide - Expensive to build and/or decommission (nuclear power stations) - Reference to target for terrorist attacks - Produces material which can be used to develop nuclear weapons/by terrorists - Negative public perception OWTTE ignore references such as unsightly, large area needed, noisy as true for most large buildings. Ignore cost of generation or restating stem ie generates electricity or supplies electricity to homes etc.	**(6)**

Level	0	No rewardable content
1	1 - 2	• A limited discussion giving one fact e.g. they give people jobs (in that area) OR they can have accidents like in Japan (after the tsunami). • the answer communicates ideas using simple language and uses limited scientific terminology. • spelling, punctuation and grammar are used with limited accuracy
2	3 - 4	• A simple discussion that states one advantage and one disadvantage OR states more than one advantage OR states more than one disadvantage. e.g. they are a reliable energy source and do not produce any carbon dioxide. OR they do not cause any global warming as they do not produce sulphur dioxide. OR they produce radioactive waste and many people don't want them built. • the answer communicates ideas showing some evidence of clarity and organisation and uses scientific terminology appropriately • spelling, punctuation and grammar are used with some accuracy
3	5 - 6	• A detailed discussion of either advantages or disadvantages AND at least a mention of the other one. e.g. They produce large amounts of electricity and don't produce carbon dioxide but they produce radioactive materials (in the fuel rods). OR They are a reliable source of energy but they can damage large areas if there is an accident and the fuel is non-renewable. • the answer communicates ideas clearly and coherently uses a range of scientific terminology accurately • spelling, punctuation and grammar are used with few errors

(Total for Question =12 marks)