NEW ZEALAND QUALIFICATIONS AUTHORITY
MANA TOHU MĀTAURANGA O AOTEAROA

Level 2, 2003

Physics: Demonstrate understanding of atoms and radioactivity (90256)

National Statistics

Assessment Report

Assessment Schedule

Physics: Demonstrate understanding of atoms and radioactivity (90256)

National Statistics

Number of Results	Percentage achieved			
	Not Achieved	Achieved	Merit	Excellence
8,842	34.4%	49.7%	13.5%	2.4%

Assessment Report

General Comments

Every candidate for a National Certificate of Educational Achievement examination paper is expected to:

- read the question and do what the question asks
- allow adequate time to complete answers
- be accurate: check and/or proofread
- use appropriate technical terms
- bring the correct equipment
- write and/or draw clearly
- use pen if work is to be eligible for reconsideration.

Achievement was fairly straightforward for candidates who made an attempt to answer all the questions.

Generally candidates were able to provide evidence of *solve problems* more easily than *give descriptions or explanations.* Opportunities for problem solving evoked a good response at all levels. The calculations in part (a) and (b) of Question 2 were done well by most candidates.

While most candidates were able to recall and describe aspects of atoms and radioactivity, attempts at explanations were poor with most candidates failing to show understanding of specific physics ideas in their answers. Lack of clarity in explanations meant very few candidates were able to gain Achievement with Excellence. For instance, most candidates were able to identify the three types of radioactivity. Few were able to give a clear and concise explanation of how they were able to identify each, related to the information provided.

Many candidates were unable to give a good definition of half life, many referring to a substance halving in size or mass, although they were able to apply the concept in the calculations.

Many candidates were able to recall Rutherford's experiment, but were unable to discuss how the results achieved were different from what was expected or relate the experimental design to the purpose of the experiment. Thomson's model of the atom was not well known. Most candidates were unaware of the term 'background radiation' and were unable to give a clear description of the process of ionization of the air by alpha particles.

Merit was achievable for reasonably able candidates who remembered that reasons, related to a physics idea, were required when giving an explanation.

Clear and concise explanations were required for excellence.

Assessment Schedule

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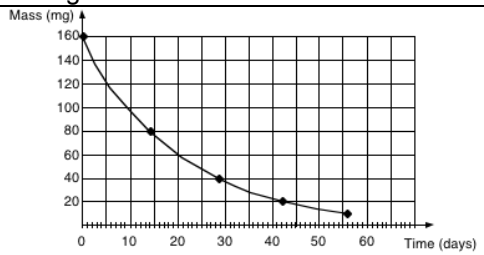
Note: Minor computational errors will not be penalised. A wrong answer will be accepted as correct provided there is sufficient evidence that the mistake is not due to a lack of understanding of the concepts in Physics.

Such evidence includes the following:
- the last written step before the answer is given has no unexpanded brackets or terms and does not require rearranging
- the power of any number that is multiplied by a power of 10 is correct.

Correct units and significant figures are required only in the questions that specifically ask for them.

Evidence Statement

Q	Evidence	Evidence contributing to Achievement	Evidence contributing to Achievement with Merit	Evidence contributing to Achievement with Excellence
Question One				
(a)	The atom is a sphere of positive charge with electrons embedded in it.	[1] both aspects of the model indicated. *Electrons* must be indicated – labelled diagram is acceptable. Idea of nucleus is not accepted.		
(b)	He expected the alpha particles to pass through undeviated.	[1] Correct answer.		
(c)	$^{4}_{2}\text{He}$ *or* $^{4}_{2}\alpha$	[1] Correct symbol and numbers – any recognized form, numbers may be other way up.		
(d)	(i) Most of the alpha particles went straight through the atom. (ii) A few alpha particles deflected through large angles or bounced straight back.	[1] Both observations correct, including relative quantities.		
(e)	Gold is malleable and easily made into thin foil. The foil has to be thin, a few atoms thick, to allow the alpha particles to penetrate. The alpha particles must be able to penetrate as observation of their path is used to verify/determine the structure of the atom.	[1] *One aspect indicated – gold is malleable, alpha can penetrate thin foil.*	[1] Thin foil will only be a few atoms thick so that the alpha particles get through, or link to the purpose of the experiment – link required. One atom thick is not accepted.	[1] Clear concise explanation shows clear understanding of the concept involved, linked to the purpose of the experiment.

Q	Evidence	Evidence contributing to Achievement	Evidence contributing to Achievement with Merit	Evidence contributing to Achievement with Excellence
Question Two				
(a)	**Source 1 gamma** Gamma rays are very penetrating and some can pass through several cm of lead. The count indicates that it was only partially stopped by 1 cm of lead. **Source 2 beta** Beta particles are more penetrating than alpha but are mostly stopped by a few mm of Al. The count shows that a small number of beta particles did penetrate, but this would be higher of the source was gamma. **Source 3 alpha** Alpha particles are the least penetrating and are easily stopped by cardboard. The remaining count is probably background radiation. Beta would only have been partially affected by the cardboard and gamma would be almost unaffected.	[1] All three identified.	[1] A clear understanding of the relative penetration.	[1] Clear concise explanation shows understanding of the relative penetration and how it would produce the numerical results shown.
(b)	Background radiation.	[1] Correct answer – no alternatives.		
Question Three				
(a)	$^{32}_{15}P \rightarrow {}^{32}_{16}S + {}^{0}_{-1}e$	[2] *Wrong symbol, correct numbers.*	[2] symbol e or β, numbers correct.	
(b)	Beta particle/electron.	[1] Correct name (not symbol) – evidence could be from 3a.		
(c)	The time taken for half of the original radioactive sample/ particles/ atoms/ nuclei/ isotope to decay into something else.	[1] Clear knowledge of half life. Half the mass/ size not accepted.		
(d)	40 mg	[2] 40, unit ignored.		
(e)		[2] Four correct data points, may include (0,160), reasonable line drawn.		
(f)	320 mg to 160 mg takes 14 days. From graph, 160mg to 100mg takes approx 9 days. Total time = 14 + 9 = 23 days. Or 320 → 160 takes same time as 160 → 50, value from graph = 23 days Or graph re-plotted for starting mass of 320 mg. Or correct log calculation $100 = 320 \times \frac{1}{2}^{t}$, t = Time/half life Total time: approx 23 days.	[2] *Graph used to determine time to 100 mg.*	[2] *Answer correct consistent with incorrect reading from graph.*	[2] Correct answer, consistent with graph, and logical reasoning.

Question Four				
(a)	95 protons 146 neutrons	[2] Both Correct.		
(b)	$\left({}^{241}_{95}\mathrm{Am}\rightarrow {}^{237}_{93}\mathrm{Np}+{}^{4}_{2}\mathrm{He}\right)$	[2] *Equation balanced for incorrect values for He / incorrect symbol – beta decay equation not accepted.*	[2] Correct balanced equation.	
(c)	Electrons are removed from air molecules. This produces an electron and positively charged molecules/particles. Or positively charged alphas remove electrons from air molecules leaving the air molecules positively charged.	[1] *Ionisation means the production of charged particles in the air, or alpha removes electrons from air molecules.*	[1] Ionisation is the result of alpha particles removing electrons from air molecules – link.	[1] Clear concise explanation indicates the process and links to the resulting positive ions.
(d)	Americium is an alpha emitter. Alpha particles would be unable to penetrate the case or a few centimetres of air so would be unlikely to affect people. The alpha particles can be absorbed by the plastic due to their relatively low energy / high rate of energy loss / slow speed.	[1] *Indication of alpha particles not being very penetrating.*	[1] Link low penetration to the absorption by the plastic case/ a few cm of air, or link to the relatively low energy/ high rate of energy loss of alpha particles.	1 Clear concise explanation links low penetration to the absorption by the plastic case/a few cm of air and to the relatively low energy of the alpha particles / high rate of energy loss / slow speed.
	Total opportunities:	Criterion 1: 8 Criterion 2: 3	Criterion 1: 4 Criterion 2: 2	Criterion 1: 4 Criterion 2: 1

Judgement Statement

Judgement statements (formerly referred to as sufficiency statements) help candidates understand how their overall results for each standard were arrived at.

The grade awarded is the highest one that has been demonstrated in all achievement criteria up to and including that grade.

Criterion One

Achievement is demonstrated if the candidate succeeds in at least **4** different opportunities.

Achievement with Merit is demonstrated if the candidate succeeds in at least **6** different opportunities, at least **2** of which must be at Merit level.

Achievement with Excellence is demonstrated if the candidate succeeds in at least **6** different opportunities, at least **2** of which must be at Merit level or higher including at least **1** at Excellence level.

Criterion Two

Achievement is demonstrated if the candidate succeeds in at least **2** different opportunities.

Achievement with Merit is demonstrated if the candidate succeeds in at least **3** different opportunities, **1** of which must be at Merit level or higher.

Achievement with Excellence is demonstrated if the candidate succeeds in at least **3** different opportunities, including at least **1** opportunity at Merit level and the Excellence level opportunity.