For Supervisor's use only

2

90256

NEW ZEALAND QUALIFICATIONS AUTHORITY
MANA TOHU MĀTAURANGA O AOTEAROA

National Certificate of Educational Achievement
TAUMATA MĀTAURANGA Ā-MOTU KUA TAEA

Level 2 Physics, 2003

90256 Demonstrate understanding of atoms and radioactivity

Credits: Two
2.00 pm Thursday 20 November 2003

Check that the National Student Number (NSN) on your admission slip is the same as the number at the top of this page.

You should answer ALL the questions in this booklet.

For all 'describe' or 'explain' questions, the answers should be written or drawn clearly with all logic fully explained.

For all numerical answers, full working must be shown and the answer must be rounded to the correct number of significant figures and given with an SI unit.

If you need more space for any answer, use the page provided at the back of this booklet and clearly number the question.

Check that this booklet has pages 2–8 in the correct order and that none of these pages is blank.

YOU MUST HAND THIS BOOKLET TO THE SUPERVISOR AT THE END OF THE EXAMINATION.

For Assessor's use only

Achievement Criteria		
Achievement	**Achievement with Merit**	**Achievement with Excellence**
Identify or describe aspects of phenomena, concepts or principles. ☐	Give descriptions or explanations in terms of phenomena, concepts, principles and/or relationships. ☐	Give concise explanations, that show clear understanding, in terms of phenomena, concepts, principles and/or relationships. ☐
Solve straightforward problems. ☐	Solve problems. ☐	Solve complex problems. ☐
Overall Level of Performance (all criteria within a column are met) ☐		

You are advised to spend 20 minutes answering the questions in this booklet.

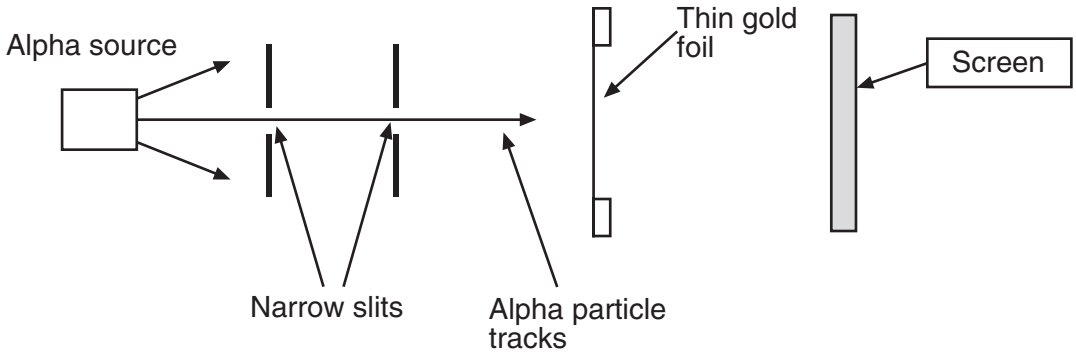
Assessor's use only

QUESTION ONE: Models of the Atom

In 1904, JJ Thomson put forward the 'Plum Pudding Model' of the atom.

(a) Describe the main features of Thomson's Model.

In 1910, Ernest Rutherford conducted an experiment to see if JJ Thomson's 'Plum Pudding Model' of the atom was an accurate description of the atom's interior. He did this by firing a beam of positively charged alpha particles at a very thin gold foil and observing where they came out.



(b) Describe what would have been observed by Rutherford if the 'Plum Pudding Model' of the atom were the correct model of the atom.

(c) Write the symbol for an alpha particle in the form ${}^{Z}_{A}\mathbf{X}$.

(d) Rutherford's observations helped him to suggest a new model of the atom.

Beside EACH conclusion below, describe the observation that led to it.

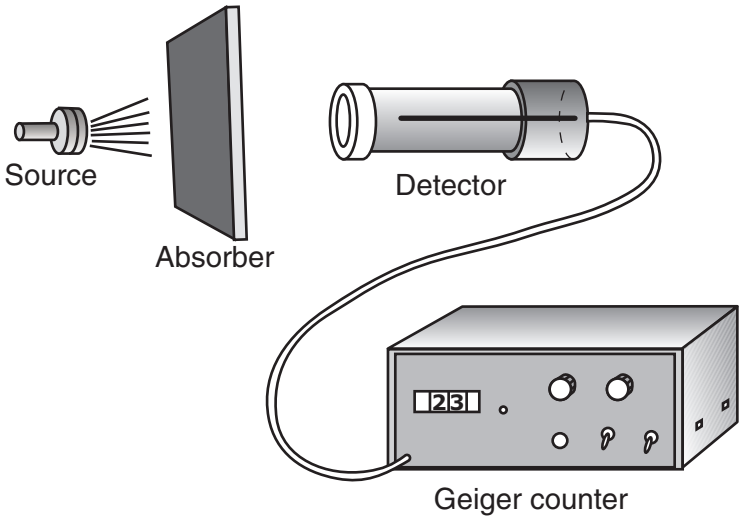
Conclusion	Observation
The atom is mainly empty space.	(i)
The nucleus is dense and positive.	(ii)

(e) Explain why a very thin gold foil was used in this experiment.

QUESTION TWO: Radioactivity

Assessor's use only

Tara carried out an experiment to determine the type of radiation coming from three different unknown sources. She placed a Geiger counter in front of each of the three sources in turn and measured the count rate. She then placed different absorbers between the source and the detector and measured the new count rates.



The table below shows her results.

Source 1	The count rate started at **21 counts** per second and dropped to **16 counts** per second with a **1 cm** thick sheet of lead.
Source 2	The count rate started at **25 counts** per second and dropped to **6 counts** per second with a **7 mm** thick sheet of aluminium.
Source 3	The count rate started at **22 counts** per second and dropped to **1 count** per second for a thin sheet of cardboard.

(a) Use Tara's results to identify the THREE types of radiation. Give a reason for EACH type.

Source 1

Type of radiation: _____

Reason: _____

_____

Source 2

Type of radiation: _____

Reason: _____

_____

Source 3

Type of radiation: _____

Reason: _____

_____

(b) At the end of the experiment, Tara moved all the radioactive sources far away from the detector. She then noticed a low, random count from the detector even when there were no radioactive sources near the detector.

What is the name given to this radiation?

_____

Assessor's use only

QUESTION THREE: Radiotherapy

Assessor's use only

An isotope of phosphorus, ${}^{32}_{15}\mathbf{P}$, is radioactive and is used in medicine for treating some blood disorders.

Phosphorus, ${}^{32}_{15}\mathbf{P}$, decays into sulfur, ${}^{32}_{16}\mathbf{S}$, by emitting a radioactive particle.

(a) Complete the decay equation for phosphorus, using the correct symbol for the unknown particle emitted.

$${}^{32}_{15}\mathbf{P} \rightarrow {}^{32}_{16}\mathbf{S} + \_\_\_\_\_$$

(b) Write a name for the particle emitted from the decay in (a).

_____

(c) Explain what is meant by the term **half-life**.

_____

_____

A patient was injected with a solution containing **160 mg** of this phosphorus isotope.

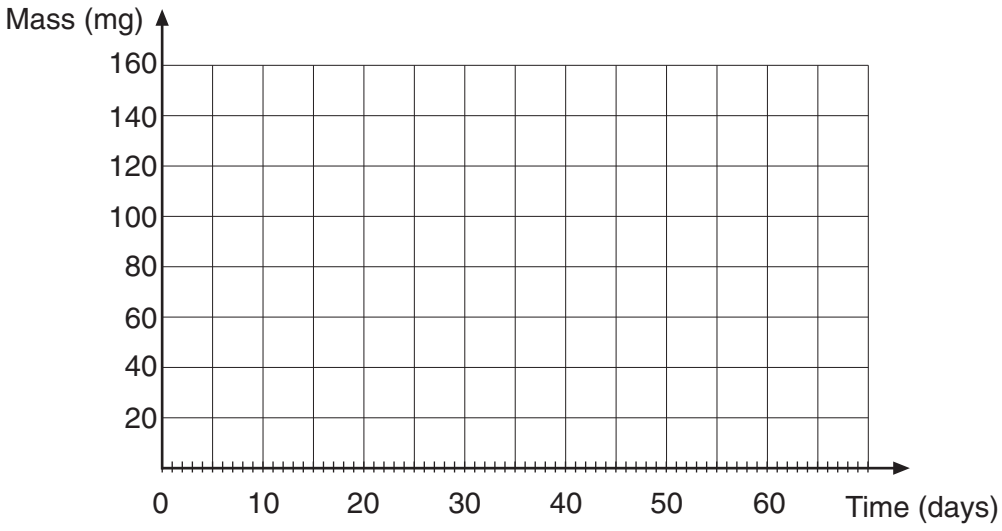
The half-life for ${}^{32}_{15}\mathbf{P}$ is **14 days**.

(d) State how much of the original phosphorus isotope remains after **28 days**.

_____

_____

(e) Draw a graph showing the decay of phosphorus for **4 half-lives** since it was injected.



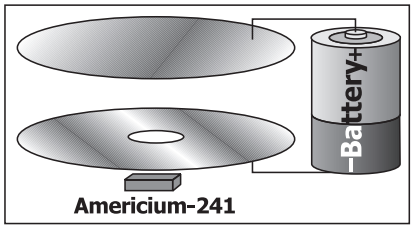
(f) Another patient was injected with **320 mg** of phosphorus.

Use your graph from (e) to help estimate the time at which there is **100 mg** of this phosphorus isotope left in this patient. Show all working.

Time at which there is 100 mg of phosphorus left = _____

QUESTION FOUR: Smoke Detectors

Americium $\left(^{241}_{95}\mathbf{Am}\right)$ is a radioactive material used in domestic smoke detectors.



(a) Write down the number of protons and neutrons in an americium $\left(^{241}_{95}\mathbf{Am}\right)$ nucleus.

Number of protons: _____

Number of neutrons: _____

(b) An americium nucleus emits an alpha particle and decays into neptunium (Np).

Write a balanced nuclear equation for the decay of americium.

(c) The alpha particles emitted by the americium ionise the air inside the smoke detector.

Explain clearly what **ionise** means in this context, and describe what is produced in this process.

(d) Explain why a smoke detector containing americium-241 attached to the ceiling is not a danger to people.

Extra paper for continuation of answers if required.
Clearly number the question.

Assessor's use only

Question Number