



Atomic Structure

FREE Online Physics GCSE Course

physicswithkate.com

Name _____ Date _____

TIME ALLOWED

35 minutes

TOTAL MARKS

41

YOU WILL NEED

a ruler, a pencil, a black or blue pen and a calculator

Instructions

- Answer **all** questions.
- Write your answers in the spaces provided.
- Use black or blue ink.
- In calculations, show clearly how you work out your answer.

Information

- The marks for each question are shown in brackets.
- The maximum mark for this test is 41.
- You are reminded of the need for good English and clear presentation in your answers.

Your score

Question	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12	Q13	Total	%
Out of	1	1	1	1	6	1	1	4	7	4	6	4	4	41	100
Your mark															

Marking your test

The full mark scheme is at the back of this booklet. Try every question first, then mark your answers in a different colour.

1 Question 1

1 mark

Atoms contain three types of particle.

The particles in the nucleus of the atom are:

Tick (✓) **one** box.

A electrons and neutrons.

☐

B electrons and protons.

☐

C neutrons and protons.

☐

(1)

Total for this question: 1 mark

2 Question 2

1 mark

Which column correctly shows the charges of the atomic particles relative to a proton?

Particle	A Relative charge	B Relative charge	C Relative charge
Electron	-1	+1	-1
Neutron	0	0	-1
Proton	+1	-1	+1

Tick (✓) **one** box.

A

☐

B

☐

C

☐

(1)

Total for this question: 1 mark

3 Question 3

1 mark

Scientists have been able to make new elements in nuclear reactors. One of these new elements is fermium. An atom of fermium is represented by the symbol below.



How many protons does this atom contain?

Tick (✓) **one** box.

A 257

☐

B 100

☐

C 157

☐

(1)

Total for this question: 1 mark

4 Question 4

1 mark

A radioactive source emits alpha particles. What might this source be used for?

Tick (✓) **one** box.

A to monitor the thickness of aluminium foil as it is made in a factory

☐

B to make a smoke detector work

☐

C to inject into a person as a medical tracer

☐

(1)

Total for this question: 1 mark

5 Question 5

6 marks

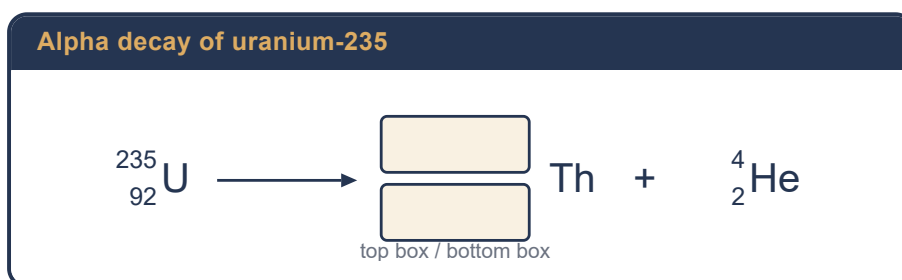
- (a) Uranium atoms do not always have the same number of neutrons.

What are atoms of the same element that have different numbers of neutrons called?

(1)

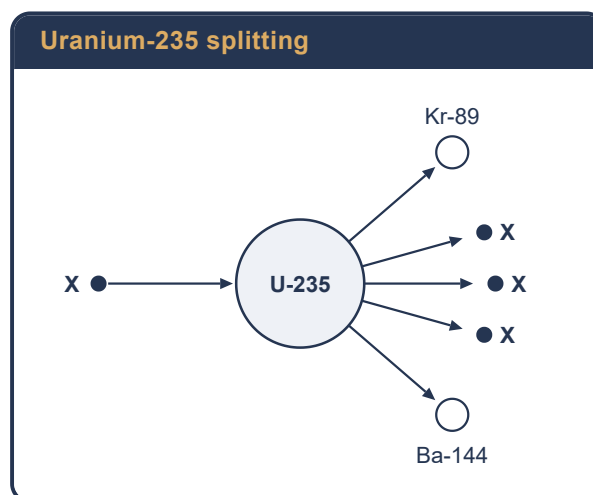
- (b) By emitting an alpha particle, an atom of uranium-235 decays into an atom of thorium. An alpha particle is the same as a helium nucleus.

The decay can be represented by the equation below. Complete the equation by writing the correct number in each of the two boxes.



(2)

- (c) The diagram shows an atom of uranium-235 being split into several pieces.



- (i) Name the process shown in the diagram.

(1)

- (ii) Name the particles labelled X.

(1)

- (d) Uranium-235 is used as a fuel in some nuclear reactors. Name another substance used as a fuel in some nuclear reactors.

(1)

Total for this question: 6 marks

6 Question 6

1 mark

Which column correctly shows the size of a nucleus relative to an atom?

	A Relative radius	B Relative radius	C Relative radius
Nucleus	0	1/2000	1/10 000
Atom	1	1	1

Tick (✓) **one** box.

A

☐

B

☐

C

☐

(1)

Total for this question: 1 mark

7 Question 7

1 mark

When a bound electron transitions from a higher energy level to a lower energy level, what does it emit?

(1)

Total for this question: 1 mark

8 Question 8

4 marks

- (a) A neutral atom has no overall charge. Explain this in terms of its particles.

(2)

- (b) Complete the sentence.

An atom that loses an electron is called an and has an overall
..... charge.

(2)

Total for this question: 4 marks

9 Question 9

7 marks

- (a) There are many isotopes of the element molybdenum (Mo). What do the nuclei of different molybdenum isotopes have in common?

(1)

- (b) When the nucleus of a molybdenum-99 atom decays, it emits radiation and changes into a nucleus of technetium-99.

Decay of molybdenum-99



What type of radiation is emitted by molybdenum-99?

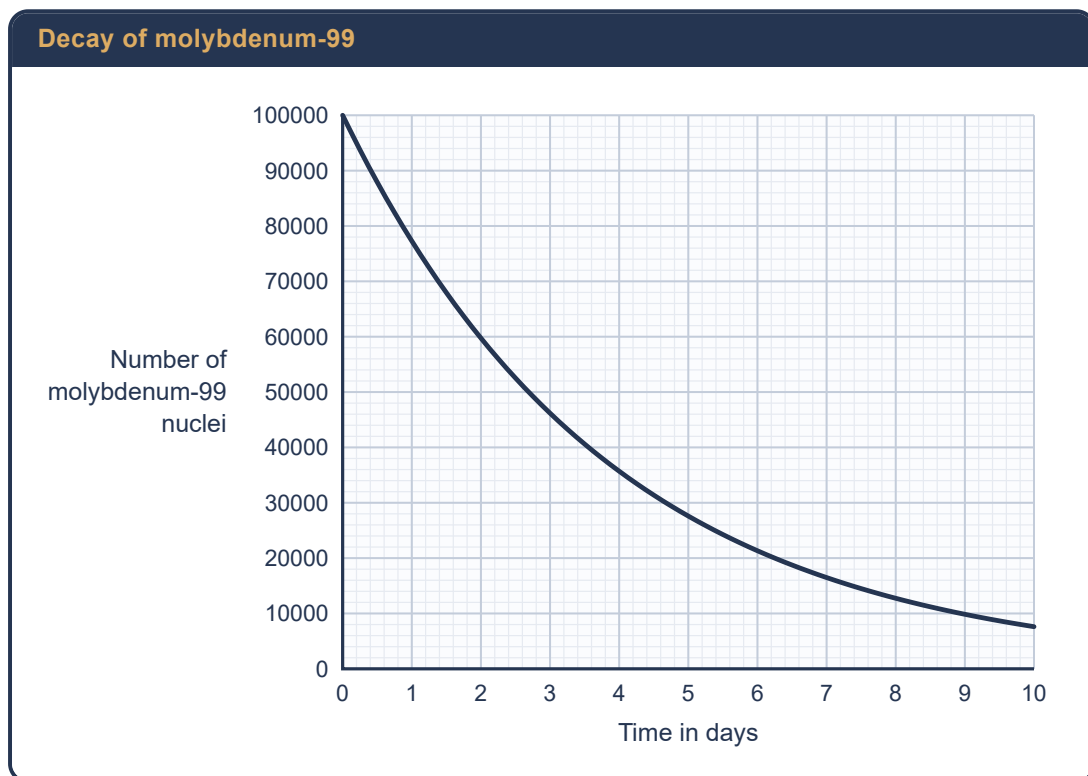
Give a reason for your answer.

(2)

- (c) Technetium-99 has a short half-life and emits gamma radiation. What is meant by the term 'half-life'?

(1)

- (d) Technetium-99 is used by doctors as a medical tracer. In hospitals it is produced inside a technetium generator by the decay of molybdenum-99 nuclei.
- (i) The graph shows how the number of nuclei in a sample of molybdenum-99 changes with time as the nuclei decay.



A technetium generator will continue to produce enough technetium-99 until 80% of the original molybdenum nuclei have decayed.

After how many days will a source of molybdenum-99 inside a technetium-99 generator need replacing? Show clearly your calculation and how you use the graph to obtain your answer.

Number of days = _____

(2)

- (ii) Even though there may be a risk, doctors frequently use radioactive substances for medical diagnosis and treatments. Suggest why.

(1)

Total for this question: 7 marks

10 Question 10

4 marks

In this question you will be assessed on using good English, organising information clearly and using specialist terms where appropriate.

Some substances are radioactive. They may emit alpha or beta particles.

Describe the characteristics of alpha particles and beta particles in terms of their:

- structure
- penetration through air and other materials.

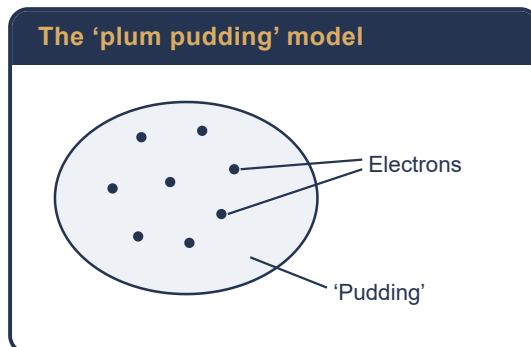
(4)

Total for this question: 4 marks

11 Question 11

6 marks

The 'plum pudding' model of the atom was used by scientists in the early part of the 20th century to explain atomic structure.

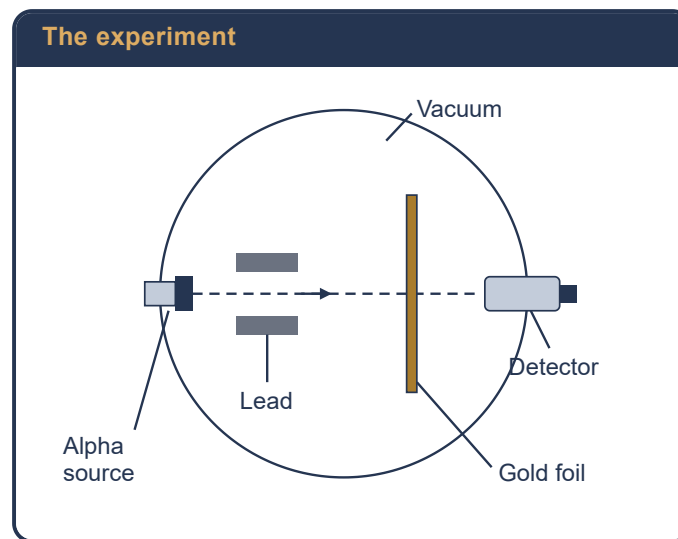


- (a) Those scientists knew that atoms contained electrons and that the electrons had a negative charge. They also knew that an atom was electrically neutral overall.

What did this allow the scientists to deduce about the 'pudding' part of the atom?

(1)

- (b) An experiment, designed to investigate the 'plum pudding' model, involved firing alpha particles at a thin gold foil.



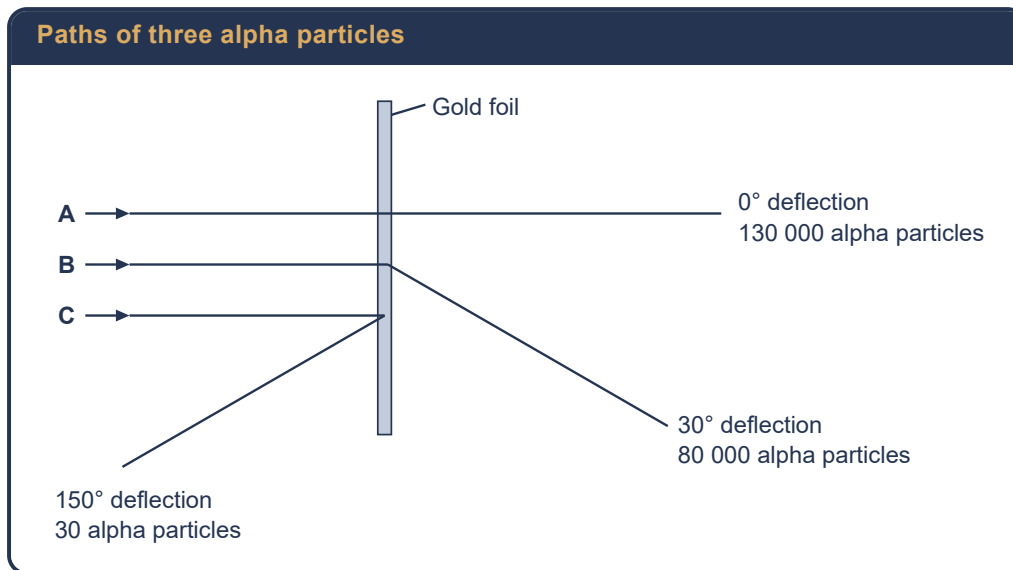
If the 'plum pudding' model was correct, then most of the alpha particles would go straight through the gold foil. A few would be deflected, but by less than 4° .

The results of the experiment were unexpected. Although most of the alpha particles did go straight through the gold foil, about 1 in every 8 000 was deflected by more than 90° .

Why did this experiment lead to a new model of the atom, called the nuclear model, replacing the 'plum pudding' model?

(1)

- (c) The diagram shows the paths, **A**, **B** and **C**, of three alpha particles. The total number of alpha particles deflected through each angle is also given.



- (i) Using the nuclear model of the atom, explain the three paths, **A**, **B** and **C**.

A

B

C

(3)

- (ii) Using the nuclear model, the scientist E. Rutherford devised an equation to predict the proportion of alpha particles that would be deflected through various angles.

The results of the experiment were the same as the predictions made by Rutherford. What was the importance of the experimental results and the predictions being the same?

(1)

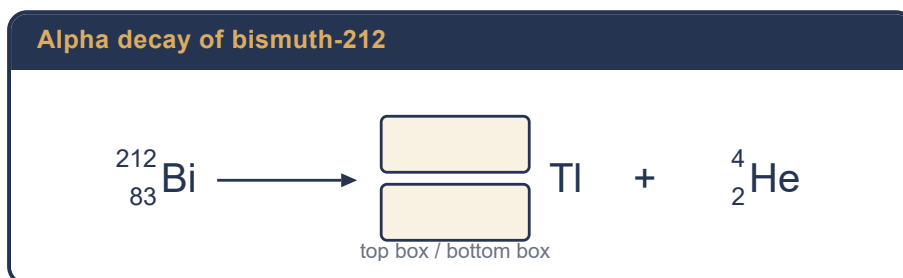
Total for this question: 6 marks

12 Question 12

4 marks

When an atom of bismuth-212 emits an alpha particle, the atom decays into an atom of thallium. An alpha particle is the same as a helium nucleus.

- (i) The equation below represents the alpha decay of bismuth-212. Complete the equation by writing the correct number in each of the two boxes.



(2)

- (ii) It is impossible for the alpha decay of bismuth-212 to produce the same element as the beta decay of bismuth-212. Explain why.

(2)

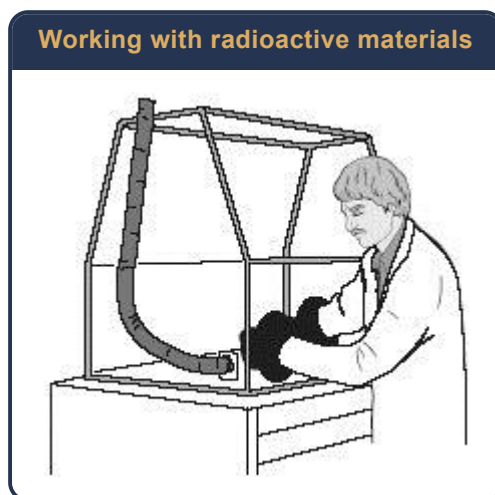
Total for this question: 4 marks

13 Question 13

4 marks

The picture shows a man at work in a factory that uses radioactive materials.

The radioactive material is kept behind glass shields. The man wears gloves so that he cannot touch the radioactive material directly.



To gain full marks in this question you should write your ideas in good English. Put them into a sensible order and use the correct scientific words.

Explain, as fully as you can, why these precautions are taken.

(4)

Total for this question: 4 marks

END OF TEST

Now mark your answers using the mark scheme that follows.

MARK SCHEME

Atomic Structure · Topic Test

[1] in the Mark column means one mark for that line.

accept / allow notes (gold) are other answers that also score.

reject / do not accept notes (red) are answers that do not.

1 Question 1 — mark scheme

1 mark

PART	ANSWER	MARK
	C neutrons and protons	1
Total: 1 mark		

2 Question 2 — mark scheme

1 mark

PART	ANSWER	MARK
	A (electron -1, neutron 0, proton +1)	1
Total: 1 mark		

3 Question 3 — mark scheme

1 mark

PART	ANSWER	MARK
	B 100	1
Total: 1 mark		

4 Question 4 — mark scheme

1 mark

PART	ANSWER	MARK
	B to make a smoke detector work	1
Total: 1 mark		

5 Question 5 — mark scheme

6 marks

PART	ANSWER	MARK
(a)	isotopes	1
(b)	top box: 231	1
	bottom box: 90	1
	correct order only	

(c)(i)	(nuclear) fission <i>accept fision</i> <i>do not accept any spelling that may be confused with fusion</i>	1
(c)(ii)	neutron / neutrons	1
(d)	plutonium (-239) <i>accept MOX (mixed oxide)</i> <i>accept Pu</i> <i>do not accept uranium-238 / hydrogen</i>	1

Total: 6 marks

6 Question 6 — mark scheme

1 mark

PART	ANSWER	MARK
	C the nucleus is 1/10 000 the radius of the atom	1

Total: 1 mark

7 Question 7 — mark scheme

1 mark

PART	ANSWER	MARK
	electromagnetic radiation <i>do not accept general words, e.g. light</i>	1

Total: 1 mark

8 Question 8 — mark scheme

4 marks

PART	ANSWER	MARK
(a)	electrons are negative and protons are positive or protons have the same size of charge as electrons, but opposite	1
	an atom has the same number of protons and electrons	1
(b)	ion	1
	positive	1

Total: 4 marks

9 Question 9 — mark scheme

7 marks

PART	ANSWER	MARK
(a)	(same) number of protons <i>reject "same atomic number" on its own: it is insufficient</i>	1
(b)	beta	1
	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 <i>accept atomic / proton number changes by 1</i> <i>accept (total) number of protons and neutrons does not change</i>	1
(c)	(average) time taken for the number of nuclei to halve or (average) time taken for the count rate / activity to halve	1
(d)(i)	6.2 (days) <i>accept 6.2 to 6.3 inclusive</i> <i>allow 1 mark for correctly calculating the number remaining as 20 000</i> <i>or allow 1 mark for the number 80 000 plus correct use of the graph (gives an answer of about 0.8 days)</i>	2
(d)(ii)	the benefit (of diagnosis / treatment) is greater than the risk (of radiation) <i>accept may be the only procedure available</i>	1

Total: 7 marks

10 Question 10 — mark scheme

4 marks

PART	ANSWER	MARK
Marks awarded for this answer will be determined by the quality of communication as well as the standard of the scientific response. Apply a 'best-fit' approach to the marking.		
0	No relevant content.	0
L1	There is a basic description of at least one of the particles in terms of its characteristics.	1
L2	There is a clear description of the characteristics of both particles or a full description of either alpha or beta particles in terms of their characteristics.	2–3

- L3** There is a clear and detailed description of **both** alpha and beta particles in terms of their characteristics.

4

Examples of the physics points made in the response — structure

- an alpha particle consists of a helium nucleus
- an alpha particle consists of 2 protons and 2 neutrons
- a beta particle is an electron
- a beta particle comes from the nucleus

Penetration

- alpha particles are very poorly penetrating
- alpha particles can penetrate a few cm in air
- alpha particles are absorbed by skin
- alpha particles are absorbed by thin paper
- beta particles can penetrate several metres of air
- beta particles can pass through a thin metal plate / foil
- beta particles can travel further than alpha particles in air
- beta particles can travel further than alpha particles in materials, e.g. metals

Total: 4 marks

11 Question 11 — mark scheme

6 marks

PART	ANSWER	MARK
(a)	it has an equal amount of positive charge <i>accept the pudding / it is positive</i>	1
(b)	(experimental) results could not be explained using the 'plum pudding' model or (experimental) results did not support the plum pudding model <i>accept (experimental) results disproved the plum pudding model</i>	1
(c)(i)	A – most of the atom is empty space or most of the atom is concentrated at the centre	1
	B – the nucleus is positive (so repels the alpha particles) <i>accept the nucleus has the same charge as the alpha particle</i>	1
	C – the nucleus is very small or the nucleus is a concentrated mass <i>accept the nucleus has a very concentrated charge</i> <i>accept the nucleus is positive if not scored for B</i>	1

(c)(ii) (if the predictions are correct, this) supports the new model

1

answers should be in terms of the nuclear model

accept supports his / the new / the nuclear theory

accept "proves" for "supports"

accept shows the predictions / Rutherford were correct

Total: 6 marks

12 Question 12 — mark scheme

4 marks

PART	ANSWER	MARK
(i)	top box: 208	1
	bottom box: 81	1
	<i>correct order only</i>	
(ii)	the number of protons determines the element	1
	<i>accept atomic number for number of protons</i>	
	alpha and beta decay produce different changes to the number of protons	1
	or	
	alpha and beta decay produce different atomic numbers	
	<i>there must be a comparison between alpha and beta, which is more than a description of alpha and beta decay alone</i>	
	<i>ignore correct reference to mass number</i>	

Total: 4 marks

13 Question 13 — mark scheme

4 marks

PART	ANSWER	MARK
	Quality of written communication: correct use of three scientific terms, e.g. radiation / α or β or γ / cells / ionisation / mutation / chromosomes / DNA / genes / cancer / contamination / irradiation	1

max 3 from:

3

- gloves prevent contamination by preventing direct contact with the radioactive material (2)
- glass absorbs radiation, preventing irradiation (2)

or any three from:

- (materials emit) radiation
- named type of radiation (α , β or γ)
- damage / harm / kill cells / chromosomes / DNA / genes
- cancer
- mutations
- ionisation
- gloves or glass absorb radiation / prevent radiation reaching the body or cells

| ignore "dangerous" on its own: it is neutral

Total: 4 marks

END OF MARK SCHEME