

13.1 Atoms, Nuclei & Radiation

Question Paper

Course	CIE A Level Physics (9702) 2019-2021
Section	13. Particle & Nuclear Physics
Topic	13.1 Atoms, Nuclei & Radiation
Difficulty	Medium

Time allowed: 20

Score: /15

Percentage: /100

Question 1

An element with an unstable nucleus decays by emitting an alpha particle to become the nucleus of a different element.

The nucleus of the new element is unstable and will emit either an α -particle or a β^- particle. This process continues until an isotope of the original element is formed.

What is the minimum possible number of the particles emitted?

- A** 5 **B** 4 **C** 3 **D** 2

[1 mark]

Question 2

Astatine is a radioactive substance; it has a nucleon number of 218 and a proton number of 85. When it decays it forms a polonium nucleus, emitting a β^- particle and an α -particle.

What are the nucleon number and the proton number of the polonium nucleus?

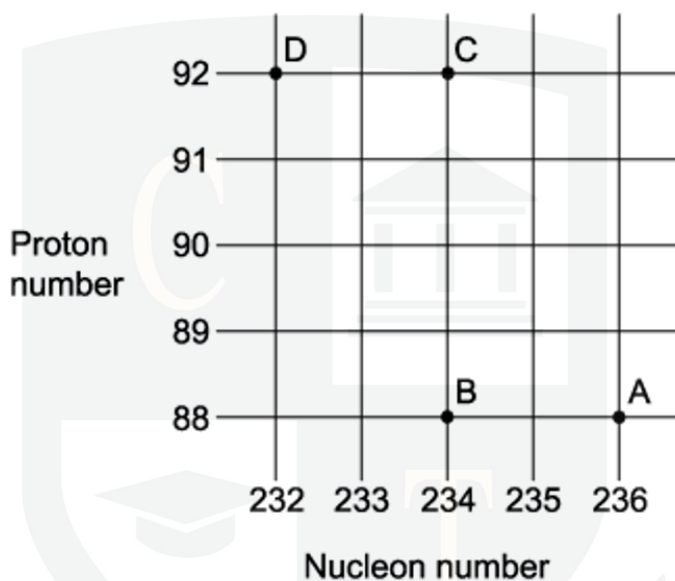
	nucleon number	proton number
A	214	84
B	214	83
C	216	83
D	215	82

[1 mark]

Question 3

A radioactive substance with a nucleon number of 234 and a proton number of 90, decays by β -emission into a daughter product which in turn decays by further β -emission into a granddaughter product.

Which letter in the diagram represents the granddaughter product?

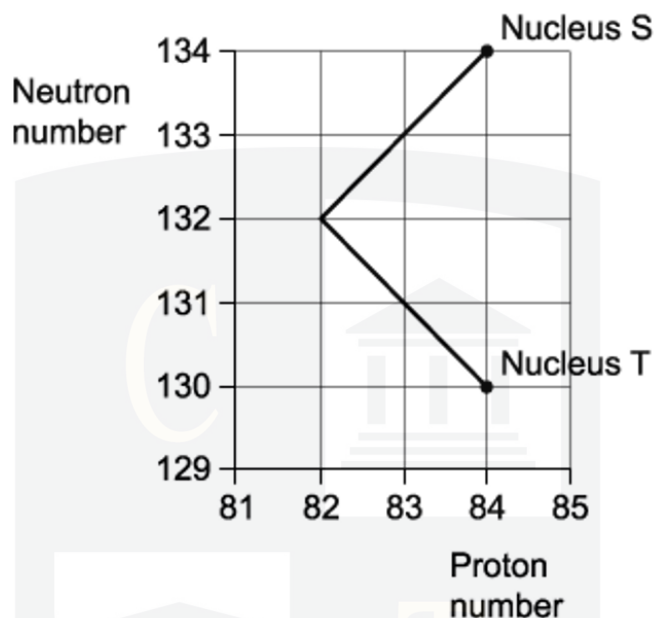


[1 mark]

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Question 4

A sequence of radioactive decays is shown in the graph of neutron number against proton number.



Nucleus S is at the start of the sequence and, after the decays have occurred, nucleus T is formed.

What is emitted during the sequence of decays?

- A one α -particle followed by one β -particle
- B two β -particles followed by one α -particle
- C two α -particles followed by two β -particles
- D one α -particle followed by two β -particles

[1 mark]

Question 5

Antimatter is a particle that is an antiparticle to the corresponding particle. A positron is the antiparticle of an electron.

What is the difference between a positron and an electron?

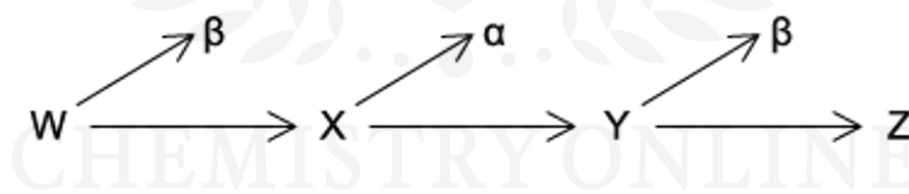
- A mass
- B magnitude of charge
- C charge
- D spin

[1 mark]

Question 6

Three successive radioactive decays are shown in the diagram below; each one results in a particle being emitted.

The first decay results in the emission of a β -particle. The second decay results in the emission of an α -particle. The third decay results in the emission of another β -particle.



Nuclides W and Z are compared. Which statement is correct?

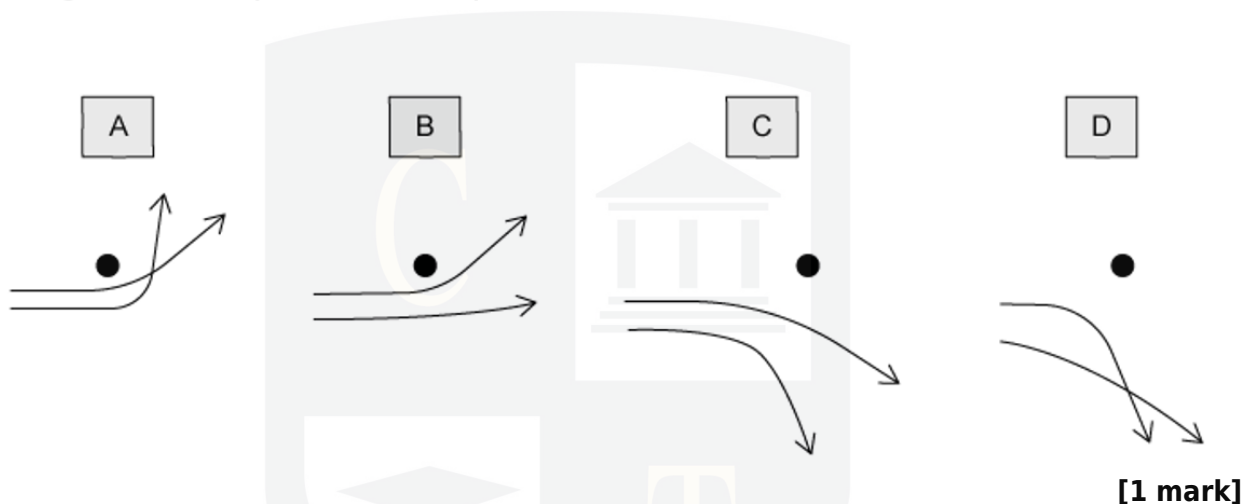
- A W and Z are isotopes of the same element
- B Z is a different element of reduced mass
- C Z is a different element of lower atomic number
- D W and Z are identical in all respects

[1 mark]

Question 7

Two α -particles with equal energies are deflected by a gold nucleus.

Which diagram best represents their paths?



Question 8

A thorium isotope has a nucleon number of 232 and a proton number of 90. It decays to form another isotope of with a nucleon number of 228.

How many alpha particles and beta particles are emitted during this decay?

	alpha particles	beta particles
A	0	4
B	1	2
C	1	1
D	2	1

[1 mark]

Question 9

The nuclides shown in the grid below are arranged according to the number of protons and neutrons in each.

A nucleus of the nuclide ${}^8_3\text{Li}$ decays by emitting a β -particle.

What is the resulting nuclide?

Number of protons	4					D	C	
	3				${}^6_3\text{Li}$	${}^7_3\text{Li}$	${}^8_3\text{Li}$	
	2		${}^3_2\text{He}$	${}^4_2\text{He}$			B	A
	1	${}^1_1\text{H}$	${}^2_1\text{H}$					
		0	1	2	3	4	5	6
		Number of neutrons						

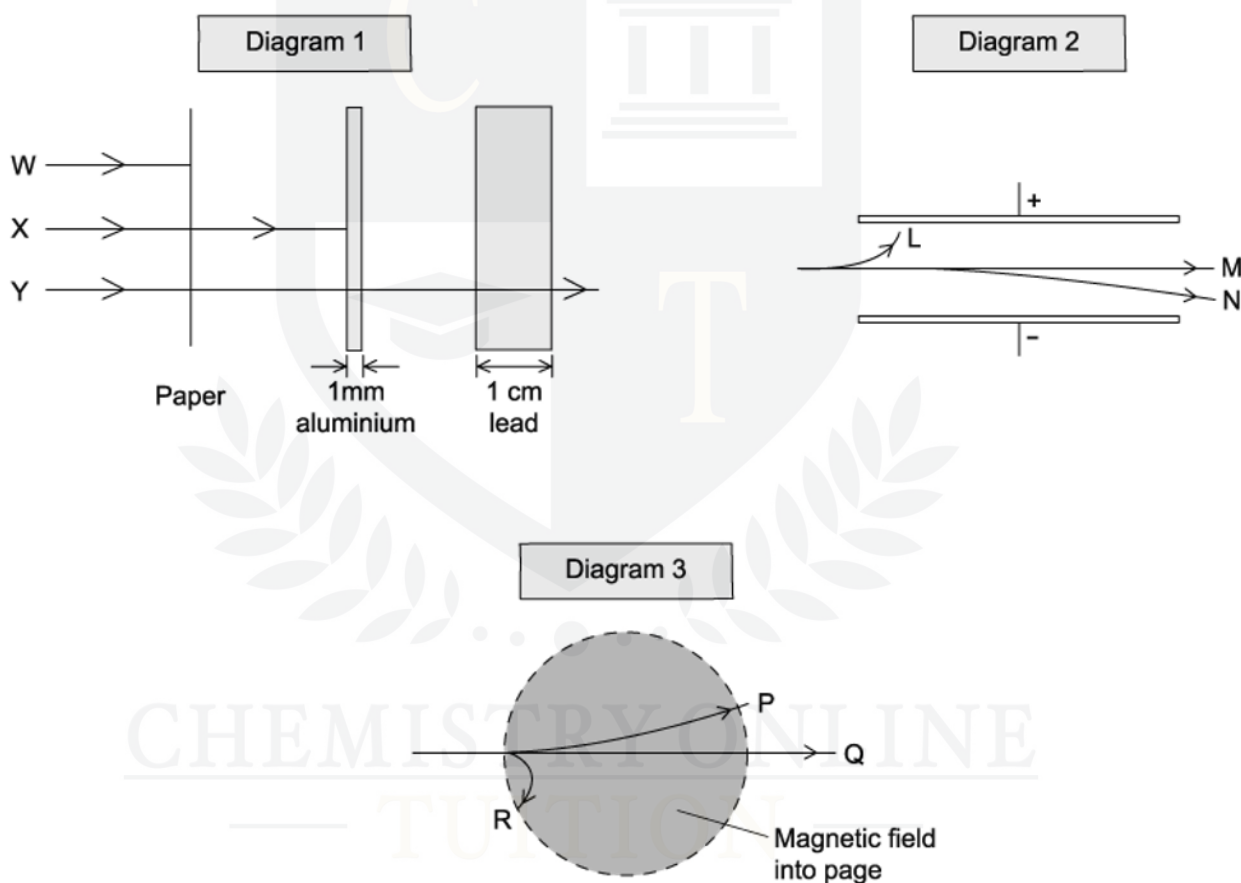
[1 mark]

Question 10

Alpha, beta and gamma radiations:

- 1 are absorbed to different extents in solids
- 2 behave differently in an electric field
- 3 behave differently in a magnetic field

Diagrams 1, 2 and 3 illustrate these behaviours.



Which three labels on these diagrams refer to the **same** kind of radiation?

- A** X, L, R **B** W, L, R **C** W, L, P **D** Y, M, P

[1 mark]

Question 11

An element emits an alpha particle from its radioactive nucleus.

The daughter nucleus then emits a beta particle, and then the daughter nucleus of that reaction emits another beta particle.

Which statement describes the final nuclide that is formed?

- A** it is a nuclide of the same element but with different proton number
- B** it is a nuclide of a different element of higher proton number
- C** it is a different isotope of the original element
- D** it is identical to the original nuclide

[1 mark]

Question 12

The isotope ${}^{222}_{86}\text{Rn}$ decays in a sequence of emissions to form the isotope ${}^{206}_{82}\text{Pb}$.

It will either emit an α -particle or a β -particle at each stage of the decay sequence.

What is the number of stages in the decay sequence?

- A** 20
- B** 16
- C** 8
- D** 4

[1 mark]

Question 13

Nucleus X decays in two stages to produce nucleus Y.

Which decay sequence will result in the highest number of neutrons in nucleus Y?

- A an α -particle followed by a β -particle
- B a β -particle followed by a γ -ray
- C a β -particle followed by another β -particle
- D an α -particle followed by a γ -ray

[1 mark]

Question 14

When α -particles are directed at gold leaf

- 1 almost all α -particles pass through without deflection,
- 2 a few α -particles deviate through large angles.

What are the reasons for these effects?

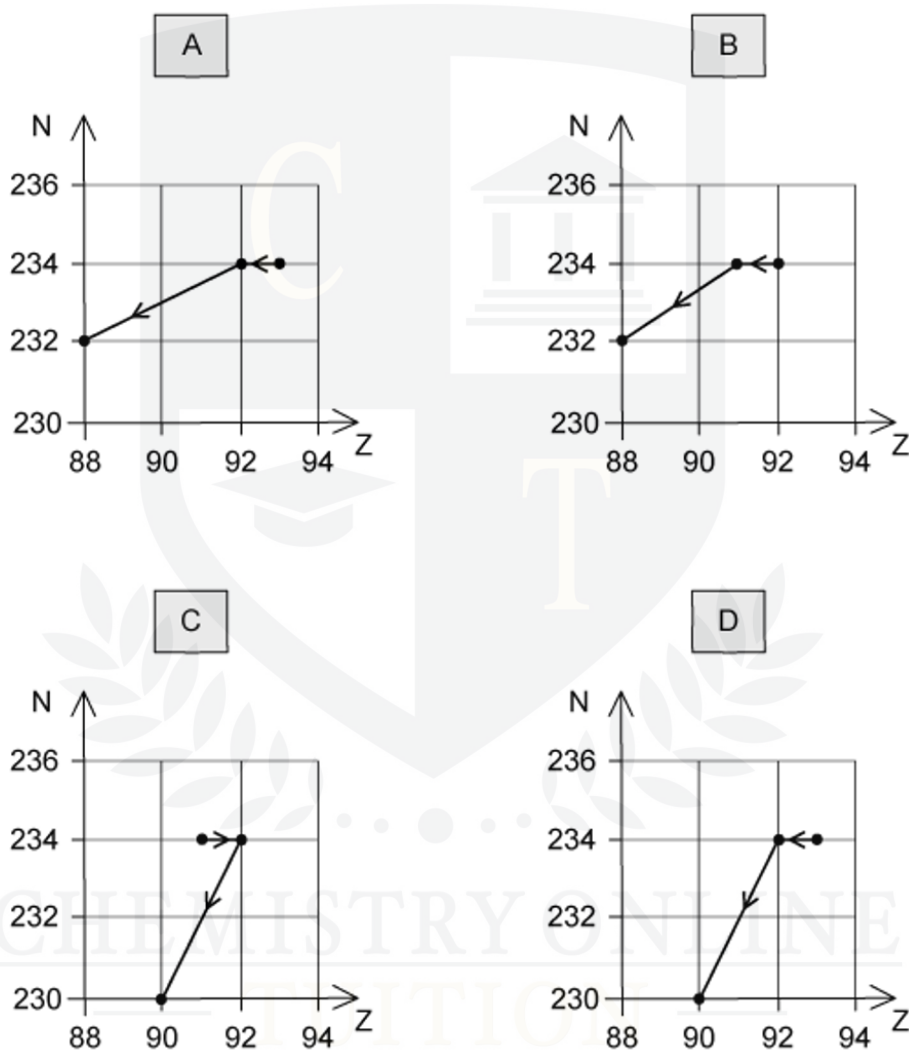
	1	2
A	the positive charge in an atom is not concentrated enough to deflect an α -particle	occasionally an α -particle experiences many small deflections in the same direction
B	the gold nucleus is very small so most α -particles miss all nuclei	occasionally the path of an α -particle is close to a nucleus
C	most α -particles miss all gold atoms	a few α -particles bounce off gold atoms
D	most α -particles have enough energy to pass right through the gold leaf	gold is very dense so a few low energy α -particles bounce back from the gold surface

[1 mark]

Question 15

A radioactive nucleus is formed by β -decay. This nucleus then decays by α -emission.

The graphs below show the nucleon number N plotted against proton number Z . Which one shows the β -decay followed by the α -emission?



[1 mark]