

The Nuclear Atom

Question Paper

Level	O Level
Subject	Physics
Exam Board	Cambridge International Examinations
Unit	Atomic Physics
Topic	The Nuclear Atom
Booklet	Question Paper

Time Allowed: 52 minutes

Score: /43

Percentage: /100

Grade Boundaries:

- 1 Which statement about a nucleus of ${}^{15}_7\text{N}$ is correct?
- A The nucleus contains 7 neutrons and 8 protons.
 - B The nucleus contains 7 neutrons and 15 protons.
 - C The nucleus contains 7 protons and 8 neutrons.
 - D The nucleus contains 7 protons and 15 neutrons.

- 2 The diagrams represent the nuclei of three atoms.



P



Q



R

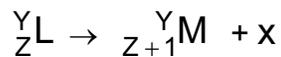
key

● = proton

○ = neutron

Which are isotopes of the same element?

- A P and Q only
 - B P and R only
 - C Q and R only
 - D P, Q and R
- 3 A radioactive material decays by this process:



What is particle x?

- A an electron
- B a helium nucleus
- C a neutron
- D a proton

- 4 A nucleus contains 94 protons and 240 nucleons. It emits an alpha-particle.

How many protons and how many neutrons are in the nucleus produced?

	number of protons	number of neutrons
A	90	144
B	90	236
C	92	144
D	92	236

- 5 In the Geiger-Marsden experiment, a beam of alpha-particles is fired at a very thin sheet of gold foil, in a vacuum.

What is deduced from this experiment?

- A** Alpha-particles are repelled by electrons.
 - B** Atoms contain air.
 - C** Electrons are found in atomic nuclei.
 - D** Nuclei are much smaller than atoms.
- 6 $^{14}_6\text{C}$ represents a nuclide of the element carbon and $^{14}_7\text{N}$ a nuclide of nitrogen.

How does a neutral atom of $^{14}_7\text{N}$ differ from a neutral atom of $^{14}_6\text{C}$?

- A** The nitrogen atom has one electron less than the carbon atom.
- B** The nitrogen atom has one neutron more than the carbon atom.
- C** The nitrogen atom has one proton less than the carbon atom.
- D** The nitrogen atom has one proton more than the carbon atom.

7 Which particle has the smallest mass?

- A alpha-particle
- B electron
- C neutron
- D proton

8 The energy emitted by the Sun is released when the nuclei of an element fuse together.

Which nuclei, when fusing together, release most of the energy in the Sun?

- A carbon
- B helium
- C hydrogen
- D uranium

9 How many nucleons are in one neutral atom of the krypton isotope $^{84}_{36}\text{Kr}$?

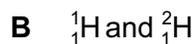
- A 36 B 48 C 84 D 120

10 A neutral atom of chlorine-37 is compared with a neutral atom of argon-37.

How do the number of electrons and the number of neutrons in each of the atoms compare?

	number of electrons	number of neutrons
A	different	different
B	different	same
C	same	same
D	same	different

11 Which nuclides have the same number of neutrons in a nucleus?



12 In the Geiger-Marsden experiment, a beam of alpha-particles is fired at a thin sheet of gold in a vacuum. The majority of the alpha-particles pass straight through the sheet without being deflected.

What does this show?

A The alpha-particle is uncharged.

B The alpha-particle is very large.

C The nucleus is positively charged.

D The nucleus is very small.

13 The compositions of four nuclei are shown in the table.

nucleus	number of protons	number of neutrons	number of nucleons
P	88	141	229
Q	88	136	224
R	89	139	228
S	92	136	228

Which two nuclei are isotopes of the same element?

A P and Q

B P and S

C Q and S

D R and S

14 A nucleus of phosphorus $^{32}_{15}\text{P}$ emits a beta-particle to form a new nucleus.

What is the nucleon number and what is the proton number of the new nucleus?

	nucleon number (mass number)	proton number (atomic number)
A	28	13
B	31	14
C	31	15
D	32	16

15 The radioactive isotope radium-226 may be shown as $^{226}_{88}\text{Ra}$.

How many protons does an atom of radium contain?

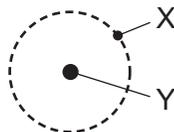
- A** 44 **B** 88 **C** 138 **D** 226

16 The nucleus of a helium atom is represented as ^4_2He .

What does a neutral atom of helium contain?

	electrons	protons	neutrons
A	2	2	2
B	2	4	2
C	4	2	2
D	4	4	2

17 In the simple model of an atom, X orbits around Y.



What are X and Y?

	X	Y
A	electron	nucleus
B	neutron	electron
C	nucleus	proton
D	proton	neutron

18 Which nucleus is produced when thorium-223 (${}^{223}_{90}\text{Th}$) emits an alpha-particle?

- A** ${}^{219}_{88}\text{Ra}$ **B** ${}^{219}_{92}\text{U}$ **C** ${}^{227}_{88}\text{Ra}$ **D** ${}^{227}_{92}\text{U}$

19 How many protons are in the nucleus of an atom of radium, ${}^{226}_{88}\text{Ra}$?

- A** 88 **B** 138 **C** 226 **D** 314

20 A radioactive nuclide ${}^{238}_{92}\text{U}$ decays into thorium by emitting an alpha-particle.

The thorium then decays into protactinium by emitting a beta-particle.

What is the symbol for protactinium?

- A** ${}^{230}_{90}\text{Pa}$ **B** ${}^{234}_{89}\text{Pa}$ **C** ${}^{234}_{90}\text{Pa}$ **D** ${}^{234}_{91}\text{Pa}$

- 21 Chlorine exists as two isotopes. One has a nucleon number (mass number) of 35 and the other has a nucleon number (mass number) of 37.

Which table shows the correct numbers of protons and neutrons in the isotopes?

A

	number of protons	number of neutrons
isotope 1	17	18
isotope 2	17	20

B

	number of protons	number of neutrons
isotope 1	18	17
isotope 2	20	17

C

	number of protons	number of neutrons
isotope 1	35	17
isotope 2	37	17

D

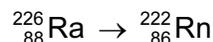
	number of protons	number of neutrons
isotope 1	17	35
isotope 2	17	37

- 22 One isotope of carbon is C_{6}^{14} .

How many neutrons and protons does each atom of this isotope contain?

	number of neutrons	number of protons
A	6	6
B	6	8
C	8	6
D	14	6

- 23 In one radioactive decay, radium (Ra) gives rise to radon (Rn) as shown.



What particle is also produced?

- A an alpha-particle
 - B a beta-particle
 - C both an alpha-particle and a beta-particle
 - D no particle but only gamma-rays
- 24 Proton number is another name for atomic number. Nucleon number is another name for mass number.

What are isotopes?

- A nuclei with different proton numbers and different nucleon numbers
 - B nuclei with different proton numbers and the same nucleon number
 - C nuclei with the same proton number and different nucleon numbers
 - D nuclei with the same proton number and the same nucleon number
- 25 ${}_{7}^{15}\text{N}$ is a nuclide of nitrogen.

How many electrons are there in a neutral atom of ${}_{7}^{15}\text{N}$?

- A 7 B 8 C 15 D 22

- 26 What are the numbers of neutrons, protons and electrons in a neutral atom of ${}_{92}^{235}\text{U}$?

	number of neutrons	number of protons	number of electrons
A	92	143	143
B	92	235	235
C	143	92	92
D	235	92	92

27 A nuclide of strontium is represented by the symbol ${}^{88}_{38}\text{Sr}$.

What does the nucleus contain?

- A 38 electrons and 50 neutrons
- B 38 neutrons and 38 protons
- C 38 neutrons and 50 protons
- D 38 protons and 50 neutrons

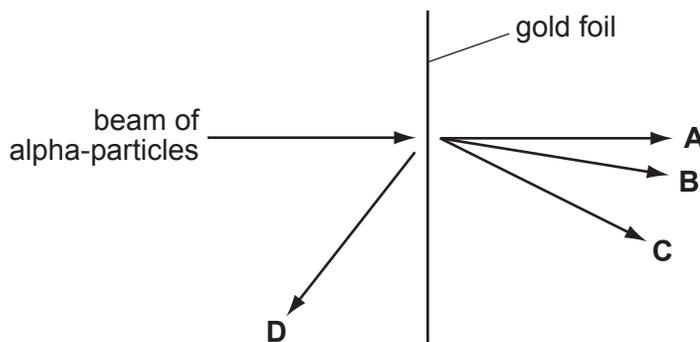
28 A nucleus of the element cobalt may be represented by the symbol ${}^{59}_{27}\text{Co}$.

What is the structure of this nucleus?

	number of protons	number of neutrons
A	27	32
B	27	59
C	59	27
D	59	32

29 A narrow beam of alpha-particles is fired at a thin piece of gold foil.

Which is the final direction of the largest number of alpha-particles?



30 A nuclide has the notation X_{23}^{48}

Which line in the table describes a different isotope of this nuclide?

	proton number (atomic number)	nucleon number (mass number)
A	23	50
B	24	48
C	48	24
D	50	23

31 The neutral atoms of all isotopes of the same element contain the same number of

- A** electrons and protons.
- B** electrons and neutrons.
- C** neutrons only.
- D** neutrons and protons.

32 Which conclusion can be drawn from the Geiger-Marsden alpha-particle scattering experiment?

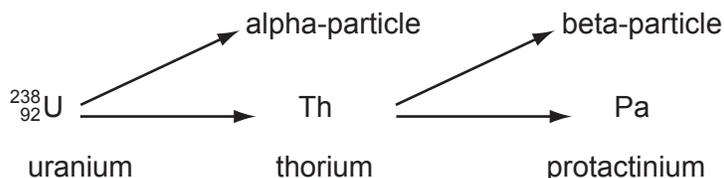
- A** A positive charge is spread throughout the atom.
- B** Electrons are arranged in orbits.
- C** Electrons are negatively charged.
- D** There is a dense nucleus in the atom.

33 A nucleus of sodium, Na, has 11 protons and 12 neutrons.

Which symbol represents this nucleus?

- A** ${}_{12}^{11}\text{Na}$ **B** ${}_{11}^{12}\text{Na}$ **C** ${}_{11}^{23}\text{Na}$ **D** ${}_{12}^{23}\text{Na}$

- 34 The uranium nucleus ${}_{92}^{238}\text{U}$ emits an alpha-particle to become thorium, which then emits a beta-particle to become protactinium.



What is the proton number (atomic number) of protactinium?

- A** 95 **B** 91 **C** 90 **D** 89
- 35 Between 1909 and 1911, Geiger and Marsden carried out experiments in which alpha particles were fired at metal foil. Most of the alpha particles passed through the foil with small deflections, but some were deflected through a large angle.

These results suggest that

- A** atoms contain clouds of electrons through which some alpha particles cannot pass.
B atoms contain neutrons that alpha particles bounce off.
C atoms have positive and negative charges spread throughout their volume.
D atoms have positive charges concentrated in a small volume.
- 36 A nucleus is represented by ${}_{91}^{230}\text{Z}$. It emits one alpha-particle and then one beta-particle.

What is the resulting nucleus X?

- A** ${}_{88}^{226}\text{X}$ **B** ${}_{89}^{226}\text{X}$ **C** ${}_{90}^{226}\text{X}$ **D** ${}_{89}^{230}\text{X}$
- 37 A nuclide of the element plutonium is ${}_{94}^{242}\text{Pu}$.

What is the number of neutrons in its nucleus?

- A** 94 **B** 148 **C** 242 **D** 336

38 Which statement defines isotopes?

- A two (or more) nuclides which have the same number of protons but different numbers of electrons
- B two (or more) nuclides which have the same number of neutrons but different numbers of electrons
- C two (or more) nuclides which have the same number of neutrons but different numbers of protons
- D two (or more) nuclides which have the same number of protons but different numbers of neutrons

39 A nucleus consists of 90 protons and 144 neutrons.

After emitting two beta-particles followed by an alpha-particle, this nucleus has

- A 86 protons and 140 neutrons.
- B 86 protons and 142 neutrons.
- C 90 protons and 140 neutrons.
- D 90 protons and 142 neutrons.

40 Deuterium ${}^2_1\text{H}$ and tritium ${}^3_1\text{H}$ are two isotopes of hydrogen.

Compared to a deuterium atom, how many protons and neutrons does a tritium atom have?

	protons	neutrons
A	more	more
B	more	same
C	same	more
D	same	same

- 41 The results of the Geiger-Marsden scattering experiment provided evidence for the presence of the nucleus within the atom.

What were scattered in this experiment?

- A alpha-particles
 - B beta-particles
 - C gamma rays
 - D gold nuclei
- 42 The nucleus of a nitrogen atom can be represented as ${}^{14}_7\text{N}$.

The nucleus of this atom consists of

- A 7 protons and 7 electrons.
 - B 7 protons and 7 neutrons.
 - C 14 protons and 7 electrons.
 - D 14 protons and 7 neutrons.
- 43 Three nuclei **P**, **Q** and **R** have proton numbers (atomic numbers) and nucleon numbers (mass numbers) as shown.

	proton number	nucleon number
P	43	93
Q	43	94
R	44	94

Which nuclei are isotopes of the same element?

- A **P** and **Q** only
- B **P** and **R** only
- C **Q** and **R** only
- D **P**, **Q** and **R**