THE NUCLEAR ATOM ATOMIC MODEL NUCLUES

Atomic Model

Describe the structure of the atom in terms of nucleus and electrons.

- In physics, an atom (Greek 'átomos' meaning "indivisible") is the smallest particle which characterise a chemical element.
- & The atom is composed of subatomic particles:
 - ø electrons;
 - ø protons;
 - ø neutrons.
- Protons and neutrons make up a dense, massive atomic nucleus, and are collectively called nucleons. The electrons form the much larger electron cloud surrounding the nucleus.





Atomic Model

Describe how the Geiger-Marsden alphaparticle scattering experiment provides evidence for the nuclear atom.

- The plum pudding model of the atom was proposed by J. J. Thomson, the discoverer of the electron in 1896.
- In this model, the atom is composed of electrons surrounded by a soup of positive charge to balance the electron's negative charge, like plums surrounded by pudding.

Plum Pudding Model

- This is also called the Gold foil experiment or the Rutherford experiment was an experiment done by Hans Geiger and Ernest Marsden in 1909 which led to the downfall of the plum pudding model of the atom.
- They observed that a very small percentage of particles were deflected through angles much larger than 90 degrees; some were even scattered back toward the source.

Geiger-Marsden Experiment

Top: Expected results of Rutherford's gold foil experiment: alpha particles passing through the plum pudding model of the atom undisturbed.



Bottom: Observed results: Some of the particles were deflected, and some by very large angles. Rutherford concluded that the positive charge of the atom must be concentrated into a very small location: the atomic nucleus.



Atom Models in History

Nucleus

Describe the composition of the nucleus in terms of protons and neutrons.

Nucleus

Define the terms *proton number* (atomic number), Z and *nucleon number* (mass number), A.

Nucleus { Explain the term *nuclide*.

- k Nuclei are made up of positive **protons** and neutral **neutrons** bound together by the strong force.
- ℵ Both protons and neutrons are referred to as nucleons.
- & The number of protons in the nucleus is called the **atomic number** Z

Nucleus



Nuclear Notation

Nucleus { Define the term *isotope*.

Nucleus

Explain, using nuclide notation, how one element may have a number of isotopes.

- The different isotopes of a given element have the same atomic number but different mass numbers since they have different numbers of neutrons.
- The chemical properties of the different isotopes of an element are identical, but they will often have great differences in nuclear stability.

Isotopes



Radioactive Isotope	Applications in Medicine	
Cobalt-60	Radiation therapy to prevent cancer	
Iodine-131	Locate brain tumors, monitor cardiac, liver and thyroid activity	
Carbon-14	Study metabolism changes for patients with diabetes, gout and anemia	
Carbon-11	Tagged onto glucose to monitor organs during a PET scan	
Sodium-24	Study blood circulation	
Thallium-201	Determine damage in heart tissue, detection of tumors	
Technetium-99m	Locate brain tumors and damaged heart cells, radiotracer in medical diagnostics (imaging of organs and blood flow studies)	

Use of Isotopes

Radioactive Isotope	Industrial Applications	
Americium-241	For uniform thickness when rolling steel and paper, determine location of oil wells	
Sodium-24	Oil well studies and to locate leaks in pipe lines	
Iridium-192	Test integrity of boilers and aircraft parts	
Uranium-235	Nuclear power plant and naval propulsion systems fuel, production of fluorescent glassware and colored wall tiles	
Californium-252	Determine moisture content of soil – important for road construction and building industries	

Use of Isotopes

Radioactive Isotope	Application in Research	
Carbon-14	Carbon dating of organisms and substances (archeology), research to determine steps involved in plant photosynthesis	
Phosphorus-32 Phosphorus-33	Used in research involving biology and genetics	
Selenium-75	Protein studies in life science	
Strontium-85	Metabolism and bone formation studies	
Hydrogen-3 or Tritium	Used to study life science and drug metabolism	

Use of Isotopes



1. In the atomic model, an atom consists of a central mass, orbited by much smaller particles.



What is the name of the central mass and of the orbiting particles?

15	central mass	orbiting particles
A	neutron	α-particles
в	neutron	electrons
С	nucleus	α-particles
D	nucleus	electrons

2. 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.

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?



- 4. 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.

¹⁶₇N is the symbol for a particular nuclide of nitrogen.

How many nucleons does this nuclide contain?

А. 7

5.

- в. 9
- с. 16
- d. 23

 An atom of the element lithium has a nucleon number of 7 and a proton number of 3.
 Which diagram represents a neutral atom of lithium?



The data below relates to the nucleus of a particular neutral atom of nitrogen.
proton number Z = 7
nucleon number A = 17
Which row represents the correct number of neutrons and electrons in this atom?

	number of neutrons	number of electrons
A	10	7
В	10	10
С	17	7
D	17	10

- 8. A nuclide of strontium is represented by the symbol ⁸⁸/₃₈ 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

9. A nucleus of the element cobalt may be represented by the symbol ⁵⁹/₂₇ Co.
 What is the structure of this nucleus?

	number of protons	number of neutrons	
Α	27	32	
в	27	59	
С	59	27	
D	59	32	

^{10.} How many neutrons and how many protons are contained in a nucleus of $^{238}_{92}$ U?

B

	neutrons	protons
Α	92	146
в	146	92
С	146	238
D	238	92

^{11.} What are the numbers of neutrons, protons and electrons in a neutral atom of $^{235}_{92}$?

	number of neutrons	number of protons	number of electrons
Α	92	143	143
в	92	235	235
С	143	92	92
D	235	92	92

^{12.} The nucleus of a neutral atom of lithium is represented by $\frac{7}{3}$ Li.

How many protons, electrons and neutrons does the atom contain?

	protons	electrons	neutrons
Α	7	7	3
в	3	7	3
С	3	4	4
D	3	3	4

 $_{13.}$ $^{15}_{7}N$ is a nuclide of nitrogen. How many electrons are there in a neutral atom of $\frac{15}{7}N$?

7 A. 8 B. 15 C.

22 D.

- 14. The nuclide notation for radium-226 is $\frac{^{226}}{^{88}}$ Ra
- How many electrons orbit the nucleus of a neutral atom of radium-226?
 - A. 0
 - в. 88
 - с. 138
 - d. 226

A uranium ²³⁸₉₂ U nucleus emits an *α*-particle.
 What are the new nucleon and proton numbers?

	nucleon number	proton number	
Α	238	88	
в	236	90	
С	234	92	
D	234	90	

- 16. A particular nuclide has the symbol ³⁷₁₇Cl. What is true for atoms of this nuclide?
 A. There are 17 nucleons in the nucleus.
 B. There are 17 protons in the nucleus.
 C. There are 37 electrons in the nucleus.
 - D. There are 37 neutrons in the nucleus.

- 17. 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

- 18. 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.

A nuclide has the notation ⁴⁸/₂₃×.
 Which line in the table describes a different isotope of this nuclide?

	proton number (atomic number)	nucleon number (mass number)	
Α	23	50	
в	24	48	
С	48	24	
D	50	23	

20. There are three nuclides of hydrogen.

nuclide 1	nuclide 2	nuclide 3
;H	2 ² H	³₁H

Which of these nuclides have the same number of protons in their nuclei?

- A. 1 and 2 only
- B. 2 and 3 only
- c. all of them
- D. none of them