

1. Which statement best describes the nucleus of an aluminum atom?
  - 1) It has a charge of +13 and is surrounded by a total of 10 electrons.
  - 2) It has a charge of + 13 and is surrounded by a total of 13 electrons.
  - 3) It has a charge of -13 and is surrounded by a total of 10 electrons.
  - 4) It has a charge of -13 and is surrounded by a total of 13 electrons.
2. Which statement concerning elements is true?
  - 1) Different elements must have different numbers of isotopes.
  - 2) Different elements must have different numbers of neutrons.
  - 3) All atoms of a given element must have the same mass number.
  - 4) All atoms of a given element must have the same atomic number.
3. Which sequence represents a correct order of historical developments leading to the modern model of the atom?
  - 1) the atom is a hard sphere → most of the atom is empty space → electrons exist in orbitals outside the nucleus
  - 2) the atom is a hard sphere → electrons exist in orbitals outside the nucleus → most of the atom is empty space
  - 3) most of the atom is empty space → electrons exist in orbitals outside the nucleus → the atom is a hard sphere
  - 4) most of the atom is empty space → the atom is a hard sphere → electrons exist in orbitals outside the nucleus
4. In Rutherford's gold foil experiments, some alpha particles were deflected from their original paths but most passed through the foil with no deflection. Which statement about gold atoms is supported by these experimental observations?
  - 1) Gold atoms consist mostly of empty space.
  - 2) Gold atoms are similar to alpha particles.
  - 3) Alpha particles and gold nuclei have opposite charges.
  - 4) Alpha particles are more dense than gold atoms.
5. Which statement about the mass of an electron is correct?
  - 1) The mass of an electron is equal to the mass of a proton.
  - 2) The mass of an electron is less than the mass of a proton.
  - 3) The mass of an electron is equal to the mass of a neutron.
  - 4) The mass of an electron is greater than the mass of a neutron.
6. An experiment in which alpha particles were used to bombard thin sheets of gold foil led to the conclusion that an atom is composed mostly of
  - 1) empty space and has a small, negatively charged nucleus
  - 2) empty space and has a small, positively charged nucleus
  - 3) a large, dense, positively charged nucleus
  - 4) a large, dense, negatively charged nucleus

7. What is the net charge on an ion that has 9 protons, 11 neutrons, and 10 electrons?  
 1) 1+                                      3) 1-  
 2) 2+                                      4) 2-
8. Which notation represents an atom of sodium with an atomic number of 11 and a mass number of 24?  
 1)  ${}^{24}_{11}\text{Na}$                                       3)  ${}^{13}_{11}\text{Na}$   
 2)  ${}^{11}_{24}\text{Na}$                                       4)  ${}^{35}_{11}\text{Na}$
9. The charge of a beryllium-9 nucleus is  
 1) +13                                      3) +5  
 2) +9                                      4) +4
10. Which symbol represents a particle with a total of 10 electrons?  
 1) N                                      3) Al  
 2)  $\text{N}^{3+}$                                       4)  $\text{Al}^{3+}$
11. Which two particles make up most of the mass of a hydrogen-2 atom?  
 1) electron and neutron  
 2) electron and proton  
 3) proton and neutron  
 4) proton and positron
12. A student constructs a model for comparing the masses of subatomic particles. The student selects a small, metal sphere with a mass of 1 gram to represent an electron. A sphere with which mass would be most appropriate to represent a proton?  
 1) 1g                                      3)  $\frac{1}{2000}$  g  
 2)  $\frac{1}{2}$  g                                      4) 2000 g
13. Atoms of different isotopes of the same element differ in their total number of  
 1) electrons                                      3) protons  
 2) neutrons                                      4) valence electrons
14. What is the total number of neutrons in an atom of  ${}^{57}_{26}\text{Fe}$ ?  
 1) 26                                      3) 57  
 2) 31                                      4) 83
15. Which isotopic notation represents an atom of carbon-14?  
 1)  ${}^6_8\text{C}$                                       3)  ${}^6_{14}\text{C}$   
 2)  ${}^8_6\text{C}$                                       4)  ${}^{14}_6\text{C}$
16. The atomic mass of element A is 63.6 atomic mass units. The only naturally occurring isotopes of element A are A-63 and A-65. The percent abundances in a naturally occurring sample of element A are closest to  
 1) 31% A-63 and 69% A-65  
 2) 50% A-63 and 50% A-65  
 3) 69% A-63 and 31% A-65  
 4) 100% A-63 and 0% A-65
17. The atomic mass of an element is the weighted average of the  
 1) number of protons in the isotopes of that element  
 2) number of neutrons in the isotopes of that element  
 3) atomic numbers of the naturally occurring isotopes of that element  
 4) atomic masses of the naturally occurring isotopes of that element
18. Compared to an electron in the first electron shell of an atom, an electron in the third shell of the same atom has  
 1) less mass                                      3) more mass  
 2) less energy                                      4) more energy
19. Write an electron configuration for an atom of aluminum-27 in an excited state.

20. Which statement best explains why most atomic masses on the Periodic Table are decimal numbers?
- 1) Atomic masses are determined relative to an H-1 standard.
  - 2) Atomic masses are determined relative to an O-16 standard.
  - 3) Atomic masses are a weighted average of the naturally occurring isotopes.
  - 4) Atomic masses are an estimated average of the artificially produced isotopes.
21. In a calcium atom in the ground state, the electrons that possess the *least* amount of energy are located in the
- 1) first electron shell
  - 2) second electron shell
  - 3) third electron shell
  - 4) fourth electron shell
22. Which electron configuration could represent a strontium atom in an excited state?
- |               |               |
|---------------|---------------|
| 1) 2-8-18-7-1 | 3) 2-8-18-8-1 |
| 2) 2-8-18-7-3 | 4) 2-8-18-8-2 |
23. Which electron configuration represents the electrons in an atom of chlorine in an excited state?
- |          |          |
|----------|----------|
| 1) 2-7-7 | 3) 2-8-7 |
| 2) 2-7-8 | 4) 2-8-8 |
24. In the modern wave-mechanical model of the atom, the orbitals are regions of the most probable location of
- |             |              |
|-------------|--------------|
| 1) protons  | 3) electrons |
| 2) neutrons | 4) positrons |
25. An atom of oxygen is in an excited state. When an electron in this atom moves from the third shell to the second shell, energy is
- 1) emitted by the nucleus
  - 2) emitted by the electron
  - 3) absorbed by the nucleus
  - 4) absorbed by the electron
26. During a flame test, ions of a specific metal are heated in the flame of a gas burner. A characteristic color of light is emitted by these ions in the flame when the electrons
- 1) gain energy as they return to lower energy levels
  - 2) gain energy as they move to higher energy levels
  - 3) emit energy as they return to lower energy levels
  - 4) emit energy as they move to higher energy levels
27. According to the wave-mechanical model of the atom, electrons in an atom
- 1) travel in defined circles
  - 2) are most likely found in an excited state
  - 3) have a positive charge
  - 4) are located in orbitals outside the nucleus
28. What is the total number of electrons found in an atom of sulfur?
- |      |       |
|------|-------|
| 1) 6 | 3) 16 |
| 2) 8 | 4) 32 |
29. Draw a Lewis electron-dot diagram for a sulfur atom in the ground state.

30. Which of these phrases best describes an atom?

- 1) a positive nucleus surrounded by a hard negative shell
- 2) a positive nucleus surrounded by a cloud of negative charges
- 3) a hard sphere with positive particles uniformly embedded
- 4) a hard sphere with negative particles uniformly embedded

31. The modern model of the atom is based on the work of

- 1) one scientist over a short period of time
- 2) one scientist over a long period of time
- 3) many scientists over a short period of time
- 4) many scientists over a long period of time

32. In the early 1900s, experiments were conducted to determine the structure of the atom. One of these experiments involved bombarding gold foil with alpha particles. Most alpha particles passed directly through the foil. Some, however, were deflected at various angles. Based on this alpha particle experiment, state *two* conclusions that were made concerning the structure of an atom.

33. Explain, in terms of atomic structure, why germanium is chemically similar to silicon.

Base your answers to questions 34 and 35 on the information below.

The accepted values for the atomic mass and percent natural abundance of each naturally occurring isotope of silicon are given in the data table below.

Naturally Occurring Isotopes of Silicon

Isotope	Atomic Mass (atomic mass units)	Percent Natural Abundance (%)
Si-28	27.98	92.22
Si-29	28.98	4.69
Si-30	29.97	3.09

34. Show a correct numerical setup for calculating the atomic mass of Si.

35. Determine the total number of neutrons in an atom of Si-29.

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36. Given the table below that shows student's examples of proposed models of the atom:

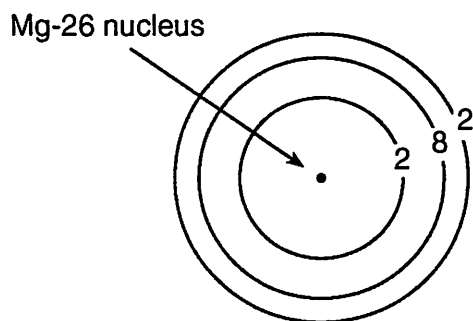
Proposed Models of the Atom

Model	Location of Protons	Location of Electrons
A	in the nucleus	specific shells
B	in the nucleus	regions of most probable location
C	dispersed throughout the atom	specific shells
D	dispersed throughout the atom	regions of most probable location

Which model correctly describes the locations of protons and electrons in the wave-mechanical model of the atom?

- 1) *A*                      2) *B*                      3) *C*                      4) *D*

Base your answers to questions 37 and 38 on the diagram below, which represents an atom of magnesium-26 in the ground state.



37. Write an appropriate number of electrons in *each* shell to represent a Mg-26 atom in an excited state. Your answer may include additional shells.

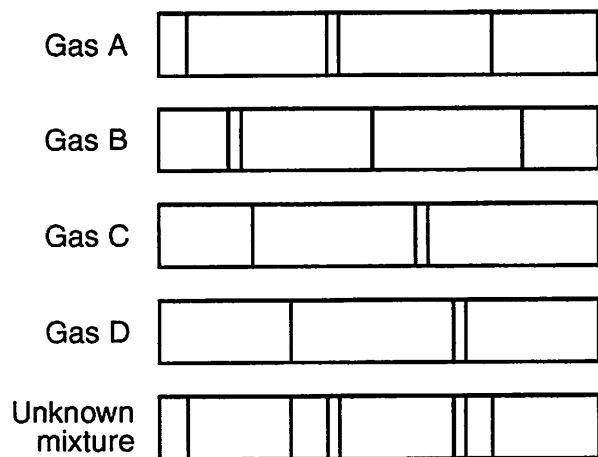
38. What is the total number of valence electrons in an atom of Mg-26 in the ground state?

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Base your answers to questions 39 and 40 on the information and the bright-line spectra represented below.

Many advertising signs depend on the production of light emissions from gas-filled glass tubes that are subjected to a high-voltage source. When light emissions are passed through a spectroscope, bright-line spectra are produced.



39. Identify the *two* gases in the unknown mixture.

40. Explain the production of an emission spectrum in terms of the *energy states of an electron*.